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Dated: February 18, 2005 Signature: Marco Jimenez



Docket No.: 393032030500
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(PATENT)

# IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In the application of:

Jun ISHII et al.

Serial No.: 10/052,838

Filing Date: January 17, 2002

For: DISCRIMINATOR FOR DIFFERENTLY MODULATED SIGNALS, METHOD USED THEREIN, DEMODULATOR EQUIPPED THEREWITH, METHOD USED THEREIN, SOUND REPRODUCING APPARATUS AND METHOD FOR REPRODUCING ORIGINAL MUSIC DATA CODE

Confirmation No.: 1876

Examiner: Marlon T. Fletcher

Art Unit: 2837

## TRANSMITTAL OF ENGLISH TRANSLATION OF PRIORITY DOCUMENT

MS Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In response to the Office Action dated November 4, 2004, enclosed herewith is the English translation of the certified priority document of Japanese Patent Application No. 2001-015099 filed January 23, 2001, from which priority is claimed.

Dated: February 18, 2005

Respectfully submitted,

By

Mehran Arjomand
Registration No.: 48,231
MORRISON & FOERSTER LLP
555 West Fifth Street, Suite 3500
Los Angeles, California 90013
(213) 892-5200

LA-776435

# DECLARATION

I, Seiichi Kuwai, residing at 7-17-5, Okusawa, Setagaya-ku, Tokyo, Japan hereby certify that I am the translator of the attached document, namely, the certified copy of Japanese Patent Application No. 2001-015099 and I certify that the following is true translation thereof to the best of my knowledge and belief.

Date: January 20, 2005

Seiichi KUWAI

# JAPAN PATENT OFFICE

This is to certify that the annexed is a true copy of the following application as filed with this Office.

Date of Application: January 23, 2001

Application Number: No. 2001-015099

Applicant(s): Yamaha Corporation

August 24, 2001

Commissioner,

Japan Patent Office    August 24, 2001 (Seal)

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[ Acceptor ] To the Director General of the Patent Office

[ International Patent Classification ] H03C 3 / 00

[Title of the Invention] Modulation method discriminating system and method, demodulator and method, audio reproducing system and method, information recoding medium and program

[ Number of Claims ] 21

[ Inventor ]

[ Address ] c/o YAMAHA CORPORATION, 10-1, Nakazawa-cho, Hamamatsu-shi, Shizuoka-ken

[ Name ] Jun ISHII

[ Inventor ]

[ Address ] c/o YAMAHA CORPORATION, 10-1, Nakazawa-cho, Hamamatsu-shi, Shizuoka-ken

[ Name ] Takashi TAMAKI

[ Applicant for Patent ]

[ Discriminative Number ] 000004075

[ Name ] YAMAHA CORPORATION

[ Attorney ]

[ Discriminative Number ] 100098084

[ Patent Attorney ]

[ Name ] Kenji KAWASAKI

[ Indication of Official Fee ]

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[ Amount of Money ] 21000

[ List of Documents Attached ]

[ Document ] Specification 1

[ Document ] Drawings 1

[ Document ] Abstract 1

[ DOCUMENT NAME ] Specification

[ TITLE OF THE INVENTION ] Discriminating system and method for modulation method, demodulating system and method, audio reproducing system and method, and information recoding medium and program

[ SCOPE OF THE PATENT CLAIM ]

[ Claim 1 ]

A discriminating system of modulation method for discriminating the modulation method of an input modulated signal, wherein the discriminating system of the modulation method being characterized by judging a wave shape of the input modulated signal to discriminate the modulation method of the aforesaid modulated signal based on the judgment result.

[ Claim 2 ]

The discriminating system of the modulation method according to claim 1 being characterized by having:

a separating means for separating the input modulated signal into modulated signals in plural channels;

a level judging means for judging the signal level of the aforesaid modulated signals in each of the aforesaid channels are at set values or more in order to output the judgment result;

a signal wave shape judging means for judging the wave shapes of the modulated signals in each of the aforesaid channels in order to output the judgment result; and

a modulation method discriminating means for outputting the judgment result by discriminating the modulation method of the aforesaid modulated signal based on the judgment results of the aforesaid level judging means and the aforesaid signal wave shape

judging means.

[ Claim 3 ]

The discriminating system of the modulation method according to claim 1 or 2, being characterized in that the aforesaid signal wave shape judging means judges the wave shape of the modulated signal in each of the aforesaid channels by judging whether the wave shape of the modulated signals in each of the aforesaid channels approximates to either of a sinusoidal wave or a rectangular wave.

[ Claim 4 ]

The discriminating system of the modulation method according to claim 1 or 2, being characterized in that the aforesaid signal wave shape judging means judges the wave shape of the modulated signal in each of the channels by judging whether the wave shape of the modulated signals in each of the aforesaid channels approximates to either of a sinusoidal wave or a rectangular wave.

[ Claim 5 ]

The discriminating system of the modulation method according to either of claims 2 to 4 being characterized by further having:

a base band signal demodulating means for executing a demodulating process for demodulating a base band signal from the modulated signals in one or more of the channels in the modulated signals in the aforesaid plural channels;

a first measuring means for measuring edge intervals of the aforesaid demodulated signal in order to output the measured result; and

a second measuring means for measuring edge interval of the modulated signal in one or more of the channels among the modulated signals in the aforesaid plural channels in order to output the measured result;

wherein the aforesaid modulation method discriminating means discriminates the modulating method of the aforesaid modulated signal based on the judgment results of the aforesaid level judging means and the aforesaid signal wave shape judging means and the judgment results of the aforesaid first and second measuring means.

[ Claim 6 ]

A demodulator for demodulating digital signals from the aforesaid modulated signal by a demodulation method associated with the modulation method discriminated by the discriminating system of the modulation method according to either of claims 1 to 5.

[ Claim 7 ]

An audio reproducing system being characterized by having:

the modulation method discriminating system according to either of claims 1 to 5;

the demodulator according to claim 6;

a data judging means for judging whether the aforesaid modulated signals are MIDI signals or audio signals or not based on the discrimination result of the aforesaid modulation method discriminating system;

a first audio signal output means for converting data strings of the aforesaid digital signals into data strings of the MIDI data and for generating audio signals from the converted MIDI data so as to output it when the aforesaid modulated signal is judged as the MIDI signal by the aforesaid data judging means; and

a second audio signal output means for outputting the aforesaid digital signal as audio signal when the aforesaid modulated signal is judged as the audio signal by the aforesaid data judging means.

[ Claim 8 ]

A modulation method discriminating method for discriminating a modulation

method of input modulated signal, wherein the modulation method discriminating method being characterized by judging a wave shape of input modulated signal so as to discriminate the modulation method of the aforesaid modulated signal based on the judgment result.

[ Claim 9 ]

The modulation method discriminating method according to claim 8 being characterized by having:

a step of separating the input modulated signal into modulated signals in plural channels;

a step of judging level for judging whether or not the signal levels of the modulated signals in each of the aforesaid channels are set values or more so as to output judgment results;

a step of judging signal wave shape for judging the wave shape of the modulated signals in each of the aforesaid channels so as to output judgment results;

a step of discriminating modulation method for discriminating the modulation method of the aforesaid modulated signal based on the discrimination results in the aforesaid step of judging level and the aforesaid step of judging signal wave shape so as to discrimination results.

[ Claim 10 ]

The modulation method discriminating method according to claim 9 being characterized by judging the wave shape of the modulated signal in each of the aforesaid channels by judging whether the wave shape of the modulated signal in each of the aforesaid channels approximates to either of a sinusoidal wave or a rectangular wave in the aforesaid step of judging signal wave shape.

[ Claim 11 ]

The modulation method discriminating method according to claim 9 being characterized by judging the wave shape of the modulated signal in each of the aforesaid channels by judging whether the wave shape of the modulated signal in each of the aforesaid channels approximates to either of a sinusoidal wave or a rectangular wave based on a ratio during a period where the amplitude of the modulated signal in each of aforesaid channels is within a predetermined range from an average value of the amplitude of said modulated signal serving as a center in the aforesaid step of judging signal wave shape so as to judge.

[ Claim 12 ]

The modulation method discriminating method according to either of claim 9 to 11 being characterized by further having:

a step of demodulating a base band signal for executing a demodulating process for demodulating a base band signal from the modulated signals in one or more of the aforesaid channels in the aforesaid modulated signals in the plural channels;

a first step of measuring for measuring edge intervals of the aforesaid demodulated signal in order to output the measured result; and

a second step of measuring for measuring edge intervals of the modulated signal in one or more of the channels among the modulated signals in the aforesaid plural channels in order to output the measured result;

wherein the modulating method of the aforesaid modulated signal is discriminated based on the judgment results in the in the aforesaid step of judging level and the aforesaid step of judging signal wave shape and the judgment results in the aforesaid first and second steps of measuring so as to output the discrimination result in the aforesaid modulation

method discriminating step.

[ Claim 13 ]

The demodulation method for demodulating the digital signals from the aforesaid modulated signal by the demodulation method associated with the modulation method discriminated by the modulation method discrimination method according to either of claims 8 to 12.

[ Claim 14 ]

The audio reproducing method being characterized by having:

the step of discriminating the modulation method of the input modulated signal by the modulation method discriminating method according to either of claims 8 to 12 so as to output the discrimination result;

the step of demodulating the digital signals from the aforesaid modulated signals based on the discrimination result in the step of discriminating the modulation method;

a data judging step for judging whether the aforesaid modulated signals are MIDI signals or audio signals based on the discrimination result of the aforesaid step of discriminating modulation method;

a first audio signal output step for converting data strings of the aforesaid digital signals into data strings of the MIDI data and for generating audio signals from the converted MIDI data so as to output it when the aforesaid modulated signal is judged as the MIDI signal by the aforesaid data judging means; and

a second audio signal output step for outputting the aforesaid modulated signal as audio signal when the aforesaid modulated signal is judged as the audio signal by the aforesaid data judging means.

[ Claim 15 ]

A computer readable recording medium which records program for executing:

a separating step for separating the input modulated signal into modulated signals in plural channels;

a level judging step for judging the signal level of the aforesaid modulated signals in each of the channels are at set values or more in order to output the judgment result;

a signal wave shape judging step for judging the wave shapes of the modulated signals in each of the channels in order to output the judgment result; and

a modulation method discriminating step for outputting the judgment result by discriminating the modulation method of the aforesaid modulated signal based on the judgment results of the aforesaid level judging means and the aforesaid signal wave shape judging means.

[ Claim 16 ]

The recording medium according to claim 15, being characterized by recording program to causing the computer to execute judgment of the wave shape of the modulated signal in each of the channels by judging whether the wave shape of the modulated signals in each of the aforesaid channels approximates to either of a sinusoidal wave or a rectangular wave in the aforesaid signal wave shape judging step.

[ Claim 17 ]

The recording medium according to claim 15, being characterized by recording program to execute judgment of the wave shape of the modulated signal in each of the aforesaid channels by judging whether the wave shape of the modulated signal in each of the aforesaid channels approximates to either of a sinusoidal wave or a rectangular wave based on a ratio during a period where the amplitude of the modulated signal in each of aforesaid channels is within a predetermined range from an average value of the amplitude

of said modulated signal serving as a center in the aforesaid in the aforesaid signal wave shape judging step.

[ Claim 18 ]

The recording medium according to either of claims 15 to 17 being characterized by recording program to execute

a base band signal demodulating step for executing a demodulating process for demodulating a base band signal from the modulated signals in one or more of the channels in the aforesaid modulated signals in the plural channels;

a first measuring step for measuring edge intervals of the aforesaid demodulated signal in order to output the measured result; and

a second measuring step for measuring edge intervals of the modulated signal in one or more of the channels among the modulated signals in the aforesaid plural channels in order to output the measured result;

wherein the aforesaid modulation method discriminating step discriminates the modulation method of the aforesaid modulated signal based on the judgment results of the aforesaid level judging step and the aforesaid signal wave shape judging step and the judgment results of the aforesaid first and second measuring steps.

[ Claim 19 ]

The recording medium according to either of claims 15 to 18 being characterized by recording program to execute a modulation step for demodulating the digital signals from the aforesaid modulated signals by the demodulation method associated with the modulation method discriminated by the modulation method discriminating step.

[ Claim 20 ]

An audio reproducing system according to claim 19 being characterized by

having:

a data judging step for judging whether the aforesaid modulated signals are MIDI signals or audio signals based on the discrimination result of the aforesaid modulation method discriminating step;

a first audio signal output step for converting data strings of the aforesaid digital signals into data strings of the MIDI data and for generating audio signals from the converted MIDI data so as to output it when the aforesaid modulated signal is judged as the MIDI signal by the aforesaid data judging means; and

a second audio signal output step for outputting the aforesaid modulated signal as audio signal when the aforesaid modulated signal is judged as the audio signal by the aforesaid data judging means.

[ Claim 21 ]

A program for executing

a separating means for separating the input modulated signal into modulated signals in plural channels;

a level judging step for judging the signal level of the aforesaid modulated signals in each of the channels are at set values or more in order to output the judgment result;

a signal wave shape judging step for judging the wave shapes of the modulated signals in each of the channels in order to output the judgment result; and

a modulation method discriminating step for outputting the judgment result by discriminating the modulation method of the aforesaid modulated signal based on the judgment results of the aforesaid level judging means and the aforesaid signal wave shape judging means.

[ DETAILED EXPLANATION OF THE INVENTION ]

[ 0001 ]

[ TECHNICAL FIELD OF THE INVENTION ]

This invention especially relates to a modulation method discriminating system and method for discriminating a modulation method of signals modulated by MIDI (Musical Instrument Digital Interface) signals and audio signals, a demodulator and the method thereof, an audio reproducing system and method, and a recording medium for recording program therefor.

[ 0002 ]

[ PRIOR ART ]

There has been a technique relating to a recording of MIDI signals which modulates a carrier in an audible band with MIDI signals, such as an FSK (Frequency Shift Keying) with two values, and produces digital data from the resultant audible signals (hereinafter simply referred to as "audio signal") through PCM (Pulse Code Modulation) to record the digital data in one of right or left musical channels of a music CD (CD-DA; Compact Disc-Digital Audio).

[ 0003 ]

[ PROBLEM TO BE SOLVED BY THE INVENTION ]

Incidentally, there are various kinds of modulation methods for acquiring the audio signals from the MIDI signals, music CD manufacturers adopt respective modulation methods. By virtue of this, a reproducing system complied with the adopted modulation method by the music CD manufacturer is needed in order to demodulate the MIDIsignal from the audio signals so that a reproducing system complied with other modulation method does not allow the demodulation of the MIDI signals. Further, although there has been a technique which transfers audio signals generated by modulating the MIDI signal

through the network, this technique has a similar problem.

[ 0004 ]

The present invention is accomplished by contemplating the above explained circumstances, and it is an object to provide a modulation method discriminating system and the method for precisely discriminating a modulation method of a modulated signal acquired by modulating the MIDI signals or the like, a demodulator and the method thereof to select a demodulation process associated with the modulated signal, an audio reproducing system and the method thereof for correctly reproducing audio signals from the modulated signals, and an information recording medium for recording the program thereof.

[ 0005 ]

[ MEANS TO SOLVE THE PROBLEM ]

To solve the above mentioned problem, the present invention is in the discriminating system of modulation method for discriminating the modulation method of an input modulated signal, and is characterized by judging a wave shape of the input modulated signal to discriminate the modulation method of the aforesaid modulated signal based on the judgment result.

In the above discriminating system of the modulation method, it is characterized by having: a separating means for separating the input modulated signal into modulated signals in plural channels; a level judging means for judging the signal level of the aforesaid modulated signals in each of the aforesaid channels are at set values or more in order to output the judgment result; a signal wave shape judging means for judging the wave shapes of the modulated signals in each of the aforesaid channels in order to output the judgment result; and a modulation method discriminating means for outputting the

judgment result by discriminating the modulation method of the aforesaid modulated signal based on the judgment results of the aforesaid level judging means and the aforesaid signal wave shape judging means.

In the above discriminating system of the modulation method, it is characterized in that the aforesaid signal wave shape judging means judges the wave shape of the modulated signal in each of the aforesaid channels by judging whether the wave shape of the modulated signals in each of the aforesaid channels approximates to either of a sinusoidal wave or a rectangular wave.

In the above configuration, it is characterized in that the aforesaid signal wave shape judging means judges the wave shape of the modulated signal in each of the channels by judging whether the wave shape of the modulated signals in each of the aforesaid channels approximates to either of a sinusoidal wave or a rectangular wave.

[ 0006 ]

In the discriminating system of the modulation method, it is characterized by further having:

a base band signal demodulating means for executing a demodulating process for demodulating a base band signal from the modulated signals in one or more of the channels in the modulated signals in the aforesaid plural channels;

a first measuring means for measuring edge intervals of the aforesaid demodulated signal in order to output the measured result; and

a second measuring means for measuring edge interval of the modulated signal in one or more of the channels among the modulated signals in the aforesaid plural channels in order to output the measured result;

wherein the aforesaid modulation method discriminating means discriminates the

modulating method of the aforesaid modulated signal based on the judgment results of the aforesaid level judging means and the aforesaid signal wave shape judging means and the judgment results of the aforesaid first and second measuring means.

The present invention is in a demodulator being characterized in that digital signals are demodulated from the aforesaid modulated signal by a demodulation method associated with the modulation method discriminated by the modulation method discriminating system.

[ 0007 ]

The present invention is in the audio reproducing system is characterized by having: the aforesaid modulation method discriminating system; the aforesaid demodulator; a data judging means for judging whether the aforesaid modulated signals are MIDI signals or audio signals based on the discrimination result of the aforesaid modulation method discriminating system; a first audio signal output means for converting data strings of the aforesaid digital signals into data strings of the MIDI data and for generating audio signals from the converted MIDI data so as to output it when the aforesaid modulated signal is judged as the MIDI signal by the aforesaid data judging means; and a second audio signal output means for outputting the aforesaid digital signal as the audio signal when the aforesaid modulated signal is judged as the audio signal by the aforesaid data judging means.

[ 0008 ]

The present invention is in a modulation method discriminating method for discriminating a modulation method of input modulated signal being characterized by judging a wave shape of input modulated signal so as to discriminate the modulation method of the aforesaid modulated signal based on the judgment result.

It is in the modulation method discriminating method being characterized by having: a step of separating the input modulated signal into modulated signals in plural channels; a step of judging level for judging whether or not the signal levels of the modulated signals in each of the aforesaid channels are set values or more so as to output judgment results; a step of judging signal wave shape for judging the wave shape of the modulated signals in each of the aforesaid channels so as to output judgment results; a step of discriminating modulation method for discriminating the modulation method of the aforesaid modulated signal based on the discrimination results in the aforesaid step of judging level and the aforesaid step of judging signal wave shape so as to discrimination results.

It is in the modulation method discriminating method being characterized by judging the wave shape of the modulated signal in each of the aforesaid channels by judging whether the wave shape of the modulated signals in each of the aforesaid channels approximates to either of a sinusoidal wave or a rectangular wave in the aforesaid step of judging signal wave shape.

[ 0009 ]

The modulation method discriminating method according to claim 9 being characterized by judging the wave shape of the modulated signal in each of the aforesaid channels by judging whether the wave shape of the modulated signal in each of the aforesaid channels approximates to either of a sinusoidal wave or a rectangular wave based on a ratio during a period where the amplitude of the modulated signal in each of aforesaid channels is within a predetermined range from an average value of the amplitude of said modulated signal serving as a center in the aforesaid step of judging signal wave shape.

In the modulation method discriminating method being characterized by further

having: a step of demodulating a base band signal for executing a demodulating process for demodulating a base band signal from the modulated signals in one or more of the aforesaid channels in the aforesaid modulated signals in the plural channels; a first step of measuring for measuring edge intervals of the aforesaid demodulated signal in order to output the measured result; and a second step of measuring for measuring edge intervals of the modulated signal in one or more of the channels among the modulated signals in the aforesaid plural channels in order to output the measured result;

wherein the modulating method of the aforesaid modulated signal is discriminated based on the judgment results in the in the aforesaid step of judging level and the aforesaid step of judging signal wave shape and the judgment results in the aforesaid first and second steps of measuring so as to output the discrimination result in the aforesaid modulation method discriminating step.

The present invention is in the demodulation method for demodulating the digital signals from the aforesaid modulated signal by the demodulation method associated with the modulation method discriminated by the modulation method discrimination method .

[ 0010 ].

The present invention is in the audio reproducing method being characterized by having: the step of discriminating the modulation method of the input modulated signal by the modulation method discriminating method so as to output the discrimination result; the step of demodulating the digital signals from the aforesaid modulated signals based on the discrimination result in the step of discriminating the modulation method; a data judging step for judging whether the aforesaid modulated signals are MIDI signals or audio signals based on the discrimination result of the aforesaid step of discriminating modulation method; a first audio signal output step for converting data strings of the aforesaid digital

signals into data strings of the MIDI data and for generating audio signals from the converted MIDI data so as to output it when the aforesaid modulated signal is judged as the MIDI signal by the aforesaid data judging means; and a second audio signal output step for outputting the aforesaid modulated signal as audio signal when the aforesaid modulated signal is judged as the audio signal by the aforesaid data judging means.

[ 0011 ]

The present invention is in the recording medium which records program for executing: a separating step for separating the input modulated signal into modulated signals in plural channels; a level judging step for judging the signal level of the aforesaid modulated signals in each of the channels are at set values or more in order to output the judgment result; a signal wave shape judging step for judging the wave shapes of the modulated signals in each of the channels in order to output the judgment result; and a modulation method discriminating step for outputting the judgment result by discriminating the modulation method of the aforesaid modulated signal based on the judgment results of the aforesaid level judging means and the aforesaid signal wave shape judging means.

It is characterized in the aforesaid information recording medium to judge the wave shape of the modulated signal in each of the channels by judging whether the wave shape of the modulated signals in each of the aforesaid channels approximates to either of a sinusoidal wave or a rectangular wave in the aforesaid signal wave shape judging step.

It is characterized in the aforesaid information recording medium to judge the wave shape of the modulated signal in each of the aforesaid channels by judging whether the wave shape of the modulated signal in each of the aforesaid channels approximates to either of a sinusoidal wave or a rectangular wave based on a ratio during a period where

the amplitude of the modulated signal in each of aforesaid channels is within a predetermined range from an average value of the amplitude of said modulated signal serving as a center in the aforesaid in the aforesaid signal wave shape judging step.

[ 0012 ]

It is characterized in the aforesaid information recording medium being characterized by having: a base band signal demodulating step for executing a demodulating process for demodulating a base band signal from the modulated signals in one or more of the channels in the aforesaid modulated signals in the plural channels; a first measuring step for measuring edge intervals of the aforesaid demodulated signal in order to output the measured result; and a second measuring step for measuring edge interval of the modulated signal in one or more of the channels among the modulated signals in the aforesaid plural channels in order to output the measured result; wherein the aforesaid modulation method discriminating step discriminates the modulating method of the aforesaid modulated signal based on the judgment result of the aforesaid level judging step and the aforesaid signal wave shape judging step and the judgment results of the aforesaid first and second measuring steps.

It is in the aforesaid information recording medium being characterized by further having a modulation step for demodulating the digital signals from the aforesaid modulated signals by the demodulation method associated with the modulation method discriminated by the modulation method discriminating step.

It is in the aforesaid information recording medium being characterized by further having: a data judging step for judging whether the aforesaid modulated signals are MIDI signals or audio signals based on the discrimination result of the aforesaid modulation method discriminating step; a first audio signal output step for converting data strings of

the aforesaid digital signals into data strings of the MIDI data and for generating audio signals from the converted MIDI data so as to output it when the aforesaid modulated signal is judged as the MIDI signal by the aforesaid data judging means; and a second audio signal output step for outputting the aforesaid modulated signal as the audio signal when the aforesaid modulated signal is judged as the audio signal by the aforesaid data judging means.

[ 0013 ]

[ EMBODIMENT OF THE INVENTION ]

Hereunder, an embodiment of the present invention will be explained with reference to drawings.

[ 0014 ]

1. Entire configuration

Fig. 1 is a block diagram illustrating an example of a configuration of an audio recording system 10 and an audio reproducing system 30 implemented by the present embodiment. An audio recording system 10 is a system which generates a base band signal having a rectangular wave shape from MIDI signals, modulates a carrier in an audible band by this base band signal, and records the resultant audio signal (modulated signal) onto a recording medium 22 such as a CD-R (CD Recordable), DVD-R (Digital Video Disc Recordable), for example, in a digital manner.

[ 0015 ]

The audio reproducing system 30 in the present embodiment is a system for reproducing MIDI signals from the recording medium 22 where audio signals associated with the MIDI signals are recorded in a digital manner, or for reproducing audio signals from a recording medium where the audio signals are recorded in a digital manner.

Especially, the audio reproducing system 30 is allowed to reproduce MIDI signals from plural kinds of recording mediums 22 where the digital recording is done by various kinds of different modulation methods.

[ 0016 ]

The audio reproducing system 30 includes a detecting system 100, a demodulation portion 30A and a tone generator 40 or the like. Herein, the detecting system 100 is a system that judges which modulation method an audio signal, which is read out from thea recording medium 22, is acquired by and supplies a signal indicating the judgment result to the demodulation portion 30A. The demodulation portion 30A is a system which allows demodulation processes corresponding to plural kinds of modulation methods and executes a demodulation process associated with the modulation method judged by the detecting system 100 to demodulate the MIDI signals from the audio signals which are read out from the recording medium 22. Further, the detailed configuration of the detecting system 100 and a specific example of the demodulation process of the demodulation portion 30A will be mentioned later.

[ 0017 ]

The tone generator 40 generates audio signals from the MIDI data which is input from the demodulation portion 30A to output thereof. The audio signal which is output from the tone generator 40 or the audio signal which is read out from the recording medium where the audio signal is digitally recorded is amplified by an amplifier which is not shown in the drawing so as to be output from a speaker system which is not shown in the drawing.

The above is the entire configuration of the present embodiment.

[ 0018 ]

2. Specific example of audio recording system 10

Prior to the explanation on the audio reproducing system 30 implemented by the present embodiment, the explanation will be made on the audio recording system 10 for recording onto the recording medium 22 in a digital manner with reference to a specific example in order to easily understand thereof. Three kinds of specifications below are exemplified as the audio recording system 10 in the present embodiment.

[ 0019 ]

< Specification for A company >

(1) Audio signals are generated by a Y modulation method by employing 16-value DPSK (signal wave shape is shown in Fig. 2).

(2) Audio signals which are generated from MIDI data are digitally recorded in a right channel when a recording medium having audio signal channels of two channels of right and left is employed.

(3) An edge interval of a base band signal (rectangular wave) of a modulated signal (audio signal) is 317.5 X n $\mu$ s (n is an arbitrary positive number).

[ 0020 ]

< Specification for B company >

(1) Audio signals are generated by a Q modulation method by employing 2-value FSK (signal wave shape is shown in Fig. 3 (b)). A header (a header portion of each of tunes) of the audio signal

(2) Audio signals which are generated from MIDI data are digitally recorded in a left channel when a recording medium 22 having audio signal channels of two channels of right and left is employed.

(3) An edge interval of a base band signal (rectangular wave) of a modulated signal (audio

signal) is either of 145 $\mu$ s, 290 $\mu$ s, 581 $\mu$ s or 3855 $\mu$ s.

[ 0021 ]

< Specification for C company >

(1) Audio signals are generated by a P modulation method by employing 2-value FSK which is different from the Q modulation method (signal wave shape is shown in Fig. 4).

(2) Audio signals which are generated from MIDI data are digitally recorded in a right channel when a recording medium 22 having audio signal channels of two channels of right and left is employed.

(3) An edge interval of a base band signal (rectangular wave) of a modulated signal (audio signal) is either of 259 $\mu$ s or 129.5 $\mu$ s.

[ 0022 ]

Next, the details of the specification for A company employing the Y modulation method by the 16-value DPSK will be explained among the above described specifications. Further, the detailed explanation of the Q modulation method and the P modulation method which are well-know technologies will be omitted.

[ 0023 ]

The details of the specification for A company will be shown in Fig. 5. As shown in Fig. 5, the modulated wave recording channel is an R (right) Channel in the recording medium 22 in this specification, and the audio signal is recorded in an L (left) Channel when the recording medium 22 is a CD, for example. The transmission speed is 12.6 kbps (kbit / sec) and it is sufficient speed for transmitting primary data of MIDI signals by considering MIDI signals include respective of START and STOP bits. A Carrier (carrier) frequency is 6.30 kHz. A Symbol (symbol) speed is 3.15 kbaud (k

symbol / sec). A bit number per each Symbol is 4 bit / symbol. An encoding method is 4 bit gray code. A modulation method is 16-value DPSK. A detection method is synchronized detection. A data synchronization method is based on synchronized information (synchronized nibble). A time delay in the audio signal upon recording is 0 msec. A time delay in audio signal upon reproduction is 500 msec. A recording level ranges from – 6.0 to – 12.0 dB (with respect to the full range). A period having no signal at a header of a tune is 2.0 sec or more, and it is determined by a necessary time period for synchronization. As a base band filter for the modulated signal, a 14 th-order cosine roll-off low-pass filter having a cut-off frequency fc = 6.3 kHz corresponding to the carrier frequency is employed.

[ 0024 ]

The audio recording system 10 for the specification of A company is illustrated in Fig. 1. The audio recording system 10 illustrated in Fig. 11 comprises a MIDI—>Data conversion module 11, a modulation module 12 and a recording module 13. MIDI data are asynchronously input into the conversion module 11. Since individual MIDI data has a bit length of multiple of 8 bits, so that it can be divided into unit data of 4 bits. The conversion module 11 supplements 4-bit synchronization signal (SYNC Nibble) similar to the above unit data with necessary units to fill intervals between MIDI data which are asynchronously input. Necessary conversion routines are executed to prevent a character synchronization signal supplemented in such a way from being mixed with the MIDI data. The conversion module 11 outputs successive bit stream data which includes original asynchronous MIDI data by executing such routines. Since these bit stream data can be segmented into a part of the MIDI data or unit data having 4 bit length serving as the synchronization signal, they are called as Nibble stream data hereinafter. The modulation

module 12 receives the Nibble stream data from the conversion module 11 to modulate a carrier having a frequency in an audio band with 4 bit unit data (Nibble) as a single symbol (symbol) and outputs the audio signal which is acquired by this modulation. The recording module 13 receives audio signals which are output from the modulation module 12 and analog or digital audio signals supplied from an external audio system which is not shown in the drawing and PCM conversion is applied on these in order to convert it into digital audio signals in a predetermined format to be recorded (recorded) in each of the audio channels of the recording medium 22.

[ 0025 ]

2-1. MIDI —> Data conversion module

Fig. 6 is a block diagram illustrating a configuration of the Data —> MIDI conversion module 11. In Fig. 6, a data converter 112 is a device that converts MIDI data asynchronously supplied to data which is allowed to be synchronized and continuously transmitted. A data conversion table for performing this conversion is stored in a data conversion memory 116. The data converter 112 fills spaces between MIDI data asynchronously supplied by supplementing them with synchronization signal (SYNC Nibble) "F" (hexadecimal representation, hereinafter data is represented in the hexadecimal manner unless it is specifically indicated otherwise) with necessary units and outputs it as successive synchronization data. Herein, the reason to adopt "F" as the synchronization data is that the kinds of MIDI data including "F" in upper 4 bits in the status byte (MSN: Most Significant Nibble) are less and such MIDI data is a so-called system message and generation frequency is low. The data converter 112 supplements MIDI data with the SYNC Nibble "F" and executes a data conversion routine of a header data in the status data, if necessary. This is because the MIDI data of which the MSN in

the status data is "F" sometimes takes place though it is less frequent, and when the SYNC Nibble "F" is supplemented while keeping "F" in the MSN in the status data as it is, the MSN "F" in the status data is not recognizable at the receiver side. The data conversion memory 16 stores a data conversion table for executing this conversion.

[ 0026 ]

Fig. 7 shows the content of the data conversion table. As shown in Fig. 7, "F" is converted into "C" when the MSN of the status data in the MIDI data is "F". To avoid adverse effects by the data conversion for "F", "C" is converted into "C4" when the MSN of the status data is "C". This is to discriminate the status data of which the MSN is converted from "F" to "C" after data conversion, and the status data of which the original MSN is "C". To avoid the adverse effect caused by the data conversion for "C", "F" is converted into "C5" when the status data is "F4" or "F5".

[ 0027 ]

In the present embodiment, the reason to substitute "F" with "C" when the MSN of the status data is "F" is as follows. First, when MSN "F" in the status data is replaced with "C", the status data after conversion is not able to discriminate it from the status data of which the MSN is originally "C". By virtue of this, "C" is replaced with "C4" for the status data of which the MSN is originally "C" in the present embodiment, as described in the above in the present embodiment. Accordingly, at every time when the status data of which the MSN is originally "C" takes place, the data "4" having 4 bits is added to the transmitted data. However, since the status data of which MSN is "C" is a data directing the program change and it occurs less frequent, it is not considered to deteriorate the data transferring efficiency even when "C" is replaced with "C4". Since the program change requires less real time processing, it does not cause a problem even when the decoding of

said data at the receiver side is delayed by replacing the data "C" for requiring the program change with "C4". Further, the command signal for the program change is rarely accompanied by data before or after it in series thereof and the processing time of said data does not affect the real time performance of the following data. Then, the present embodiment replaces "F" with "C" when the MSN of the status data is "F".

[ 0028 ]

Further, there will be mentioned the reason to add "5" of 4 bits data in the data conversion of the MIDI data of which the status byte is "F4" or "F5" in the embodiment. The contents of commands of the MIDI data which the status byte is "F4" or "F5" are undefined so that the issue of the transferring data efficiency or the like does not need to be considered at present. However, contemplating future usage and data transparency, a data conversion table is provided for these MIDI data in the present embodiment. The data conversion by adding 4 bit to these MIDI data is done by considering to avoid adverse effect on the following MIDI data in real time performance.

[ 0029 ]

A synchronization data generator 113 interleaves a SYNC Nibble between data which are asynchronously supplied from the data converter 112 to create successive synchronization data. "F" is used as the SYNC Nibble in the present embodiment.

[ 0030 ]

Next, operations of the MIDI —> Data conversion module 11 as shown in Fig. 6 will be explained with reference to Fig. 8 to Fig. 13. Fig. 8 is a view to illustrate MIDI data asynchronously supplied to the data converter 112 shown in Fig. 6. In the drawing, "904040" and "804074" show MIDI data, respectively, and the dotted lines represent cycles where the MIDI data do not exist. The data converter 112 executes the data

conversion based on the above mentioned data conversion table (Fig. 7) and since the MSN of the MIDI data illustrated in Fig. 8 is neither "C" nor "F", the data conversion is not specifically executed for said data to supply it to the synchronization data generator 113. Fig. 9 is a view to show the signal which is output from the data converter 112 in this case. And the synchronization data generator 113 interleaves the SYNC Nibbles "F" in between these data depending on the time interval between the data without leaving any space. Then, successive Nibble stream data as shown in Fig. 10 are generated.

[ 0031 ]

Further, another example of the data conversion by the data converter 112 will be shown. Fig. 11 is a view to illustrate the MIDI data "CF" supplied to the data converter 112. In this case, the data converter 112 converts data based on the data conversion table (Fig. 7) to convert the MSN "C" to "C4" with respect to said MIDI data. Namely, the data converter 112 supplies said data to the synchronization data generator 113 after data conversion of the supplied MIDI data "CF" to "C4F". Fig. 12 illustrates the content of the output data of the data converter 112 in this case. The synchronization data generator 113 interleaves the SYNC Nibble "F" in between these data to generate the successive Nibble stream data as shown in Fig. 13.

[ 0032 ]

As in the above, the MIDI data which are asynchronously supplied to the data converter 112 are converted into the Nibble stream data by the data converter 112 and the synchronization data generator 113.

[ 0033 ]

2-2. Modulation module

Next, the modulation module 12 in Fig. 1 will be explained. When a unit data of

4 bits is input from the MIDI —> Data conversion module 11 into the modulation module 12, the unit data is converted into the gray code and a next phase is created by adding a phase corresponding to the gray code to a phase one timing before. The reason to adopt such differential method is that the receiving side (reproducing side) is not synchronized unless the phase rotates when the SYNC Nibble "F" is successively input, for example, and that the variation in phase surely takes place by adopting the differential signal as the modulated signal.

[ 0034 ]

A constellation of the modulated signal is set as shown in Fig. 14 and Fig. 15. Fig. 14 shows a relation between I components and Q components represented by 16 units of 4 bit gray codes, relative phase (difference between phases) and a Q-I coordinate system in a list, and Fig. 15 is a view in the Q-I coordinate system representing these. In the constellation of modulated signal shown in Fig. 14 and Fig. 15, 0FH(1111) is set as a phase of 157.5 deg and allocated with gray codes in a counter clockwise direction. Since 0FH is equal to the phase of 157.5 deg and the phase is assured to successively change while Sync Nibble (4 bit) is received for synchronization. Since Status and Data alternately appear in the MIDI data, it is designed to uniformly scatter data being equal to or larger, or being equal to or smaller than 08H to increase the relative phase of gray codes as large as possible. When a differential value is 0CH, the relative phase is zero so that the phase changes unless the successive occurrence of (1) 00H —> 04H —> 08H —> 0CH —> 00H · · · (2) 01H —> 05H —> 09H —> 0DH —> 01H · · · (3) 02H —> 06H —> 0AH —> 0EH —> 02H · · · (4) 03H —> 07H —> 0BH —> 0FH —> 03H · · · . There is extremely low possibility that such special data successively take place in MIDI data so that scramble may not be operated.

[ 0035 ]

More specifically, since Status (bit 3 in the header Nibble is "1") and Data (bit 3 in the header Nibble is "0") alternately appear in the constellation of modulated signal as shown in Fig. 14 and Fig. 15, it utilizes that it is assured that values of "1" in the bit 3 of each Nibble by segmenting the MIDI signal into 4 bit unit, namely, those of which the most significant bit is "1" do not successively take place so that those having "1" in the bit 3 are gathered around zero degree in the relative phase to avoid the succession of data around zero degree (① in Fig. 15). This is because the changing point in data is not detected when the data around zero degree successively take place and it is considered that the synchronization trigger is failed upon demodulation so as to avoid this. Focusing on the fact that no-signal (1111), MSN (1011) for control change (Bxxxxx) (x means undetermined), and MSN (1001) for note-on (90xxxx) are frequently used, these data are gathered around 180 degrees in the relative phase to easily detect these data changing points (② in Fig. 15).

[ 0036 ]

Fig. 16 is a block diagram showing a configuration of the modulation module 12. The Nibble which is input from the an input node 1201 is hold for one symbol time period (4 bit) by a 0-order hold 1202 to be converted into the gray code by a gray code converter 1203. The 4 bit data which is output from the gray code converter 1203 is input into a modulo function part 1205 through an adder circuit 1204. The modulo function portion 1205 executes a process for outputting the remainder of division of the input numerical value by 16. The output of the modulo function portion 1205 is input into the adder circuit 1204 through a delay circuit 1206 for delaying 1 data signal to be added to the output from the gray code converter 1203. With the adder circuit 1204, modulo function

portion 1205 and delay circuit 1206, the relative phase which is output from the gray code converter 1203 is converted into a value representing the absolute phase.

[ 0037 ]

The 4 bit data representing the absolute phase which is output from the modulo function portion 1205 is input into a real part converter 1207 for calculating a real component (In-Phase component) and an imaginary part converter 1208 for calculating an imaginary component (Quadrature-Phase component). The real component which is output from the real part converter 1207 and the imaginary component which is output from the imaginary part converter 1208 are input into a multiplying circuit 1209 and a multiplying circuit 1210, respectively. A cosine component of a carrier signal having a unit amplitude which is output from a cosine circuit 1211 and a sinusoidal component of the carrier signal having a unit amplitude which is output from a sinusoidal circuit 1212 are input into the multiplying circuits 1209 and 1210, respectively, to be multiplied by the real component and the imaginary component. An output of a multiplying circuit 1213 for outputting a reference phase signal $2\pi$ fct by multiplying an output t of a clock circuit 1214 for generating a signal representing a time for every predetermined sampling cycles by $2\pi \cdot$ fc is input into both of the cosine circuit 1211 and the sinusoidal circuit 1212 (fc: carrier frequency). The outputs of the multiplying circuit 1209 and the multiplying circuit 1210 are input into an adder circuit 1215 to be added together therein. And an audio signal modulated based on the MIDI signal of 4-bit unit which is input from the input terminal 1201 is output from an output terminal 1216 connected to the output of the adder circuit 1215. With the above configuration, a quadrature modulation circuit is established by the multiplying circuit 1209, multiplying circuit 1210, cosine circuit 1211 and sinusoidal circuit 1212, clock circuit 1214, multiplying circuit 1214 and adder circuit 1215.

[ 0038 ]

3. Details of audio reproducing system implemented by the present embodiment

Next, the details of the audio reproducing system 30 implemented by the present embodiment will be explained.

[ 0039 ]

3-1. Example of the detecting system 100

① Entire configuration of the detecting system 100

Fig. 17 is a block diagram showing the configuration of the detecting system 100.

Audio signals which are read out from the recording medium 22 or the like are separated into audio signals for a right channel and audio signals for a left channel by an L/R separating circuit (separating means) 109. The audio signals for the right channel are input into a wave shape discriminator 101, a level detector 102, a P detector 103 for detecting modulated wave by the P modulation method and a Y detecting portion104 for detecting the modulated wave shape by the Y modulation method. The audio signals for the left channel are input into a wave shape discriminator 105, a level detector 106, and a Q detector 107 for detecting the modulated wave shape by the Q modulation method as they are. Then, the outputs from the wave shape detectors 101 and 105, level detectors 102 and 106, Y detecting portion 104, P detector 103 and Q detector 107 are supplied to a total judging portion 108.

[ 0040 ]

The wave shape detectors (signal wave shape judging means) 101 and 102 output signals for discriminating wave shape of the audio signals, respectively, by detecting a ratio of a period where the amplitude of the input audio signal is within a predetermined range about an average value of the amplitude of said signal serving as a center. The

level detectors (level judging means) 102 and 106 output signals representing whether it is in a no-sound state or not by detecting the signals level of the input audio signal is equal to a predetermined value or more, respectively.

[ 0041 ]

The total judging portion (modulation method discriminating means) 108 discriminates the modulation method of the audio signals which are read out from an internal recording medium 22 and the audio signals which are externally input thereinto, and judges whether the audio signal is the MIDI signal or audio signal or not. Namely, the total judging portion 108 includes a modulation method discriminating table for discriminating the modulation method of the audio signals which are read out from the recording medium 22 or for judging whether the audio signal is the audio signal or not based on the outputs of the wave shape discriminators 101 and 105, level detectors 102 and 106, the Y detecting portion 104, the P detector 103 and the Q detector 107. The total judging portion 108 comprises a logical calculating portion 108a for executing various discriminations by referring to the modulation method discriminating table; and an A detector 108b for detecting whether the audio signal is audio signal or not based on the outputs from the Y detecting portion 104, the P detector 103 and the Q detector 107.

[ 0042 ]

Next, the Y detecting portion 104, P detector 103, Q detector 107 and A detector 108b will be explained with reference to a block diagram shown in Fig. 18. The Y detecting portion 104 comprises a demodulator 110 (base band signal demodulating means) 110 and a Y detector (first measuring means) 111. The demodulator 110 demodulates the modulated signal which is input into a Carrier terminal and extracts the base band signal to output it from a Base terminal. The Y detector 111 outputs a "1"

level in a 2-value signal from a Trigger terminal when a signal which is input into a Signal terminal shows a predetermined level change; outputs a "1" level in a 2-value signal from a Curr terminal when an interval between the predetermined level changes approximately matches 317.5 X n $\mu$ s (n is an arbitrary positive number) defined in the above mentioned Y modulation method; and judge it as a signal complied with the Y modulation method when the condition that the interval between the predetermined level changes approximately match 317.5 X n $\mu$ s is successively fulfilled for several times so as to output a "1" level in a 2-value signal from a Status terminal.

[ 0043 ]

The P detector (second measuring means) 103 outputs a "1" level of 2-level signal from the Trigger terminal when a predetermined level change takes place in the signal from the right channel which is input into the Signal terminal through the input terminal 101a; outputs a "1" level in a 2-value signal from the Curr terminal when the interval of the predetermined level changes approximately matches either of 259 $\mu$ s or 129.5 $\mu$ s defined in the above mentioned P modulation method; and judges it as the signal by the P modulation method when the condition that the interval between the predetermined level changes approximately matches either of 259 $\mu$ s or 129.5 $\mu$ s successively fulfills for predetermined times to output a "1" level in a 2-value signal from the Status terminal.

[ 0044 ]

The Q detector (second measuring means) 107 outputs a "1" level in a 2-value signal from the Trigger terminal when the signal from the left channel input into the Signal terminal through the input terminal 100b shows a predetermined signal change; outputs a "1" level in a 2-value signal from the Curr terminal when the interval between the predetermined level change approximately matches either of 145 $\mu$ s, 290 $\mu$ s, 581 $\mu$ s

or 3855 μ s defined in the above mentioned Q modulation method; and judges it as the signal of the Q modulation method when the condition that the interval between the predetermined level change approximately matches either of 145 μ s, 290 μ s, 581 μ s or 3855 μ s successively fulfills for predetermined times to output a "1" level in a 2-value signal from the Status terminal.

[ 0045 ]

An OR circuit 115 makes a logical summation of output signals from each of the Trigger terminals of the Y detecting portion 104, the P detector 103 and the Q detector 107 to output it to a Trigger terminal of the A detector 108b. Namely, when the signal of "1" level is output from either of the Trigger terminals of the Y detecting portion 104, the P detector 103 or the Q detector 107, the OR circuit 115 outputs a "1" level in a 2-value signal. A NOR circuit 116 makes a negative summation calculation (NOR calculation) of the output signals from each of the Curr terminals of the Y detecting portion 104, the P detector 103 and the Q detector 107 and outputs the result to an Audio terminal of the A detector 108b. Namely, the NOR circuit 116 outputs a "1" level in a 2-value signal when no "1" level signal is output from any of the Curr terminals of the Y detecting portion 104, the P detector 103 and Q detector 107.

[ 0046 ]

The A detector 108b detects the input of the audio signal which does not include a predetermined MIDI modulated signal and judges that both of the signals from the right and left channels, which are input from the terminal 100a and the terminal 100b, are audio signals which do not include the predetermined MIDI modulated signals if either of following two conditions meets to output a "1" level of a 2-value signal from the Status terminal. The first condition is that a state that the "1" level signal is successively input

into the Audio terminal for a predetermined number of times or more. Namely, if the state that none of the modulation method is detected by any of the detectors 120, 130 and 140 continues for a predetermined number of times, the input signal is judged as the audio signal. On the other hand, the second condition is that other modulation method is not fixed when a predetermined period of time lapses after the signal is input into the terminal 100a or 100b. Namely, if the modulation method is not determined when a predetermined time period lapses after a predetermined level change in the terminal 100a or 100b is started to be detected (time is running out), the input signal is judged as the audio signal.

[ 0047 ]

The logical calculating portion 108a discriminates the modulation method of the audio signal which is read out from the recording medium 22 and discriminates whether the audio signal is the MIDI signal or audio signal or not in order to report the discrimination result to the demodulating portion 30A.

[ 0048 ]

② The configuration of wave shape detectors 101 and 105 in the detecting system 100

Next, the internal configuration of the wave shape detectors 101 and 105 will be explained with reference to Fig. 19. Since the wave shape detectors 101 and 105 are the same configurations, the explanation will be made on the wave shape detector 101 only. In the example shown in the block diagram in Fig.19, the wave shape detector 101 comprises an absolute value detector 101a, low pass filters (LPF) 101b and 101d, and a comparator 101c. In the wave shape detector 101, the absolute value detecting circuit 101a outputs an absolute value [ S ] of the audio signal which is input from the right channel and the low pass filter 101b outputs an average value [ Sa ] of the absolute value

[ S ] of the audio signal.

As shown in Fig. 20, the comparator 101c compares the absolute value [ S ] of the audio signal with two threshold values which are within ± 20 % of the average value [ Sa ], and outputs the "1" level of the two-value signal from the AND circuit when the absolute value [ S ] is within ± 20 % of the average value [ Sa ] and outputs the "0" level of the two-value signal when it is out of such range. The low pass filter (LPF) 101d smoothes the signal which is output from the comparator 101c and outputs it as a wave shape discriminating signal SWA.

[ 0049 ]

Specifically, as shown in Fig. 21, for example, if a sinusoidal wave W1 (Fig. 21 (a)) is input into the wave shape detector 101, the absolute value [ S1 ] of the sinusoidal wave W1 is output from the absolute value detector 101a and the average value [ Sa1 ] of the absolute value [ S1 ] of the sinusoidal wave W1 is output from the low pass filter 101b (for example, cut-off frequency 50 Hz) (see Fig. 21 (b)).

When the absolute value [ S1 ] is between the values [ Sa1H ] and [ Sa1L ] within ± 20 % of the average value [ Sa1 ], the "1" level of the two-value signal is output from the comparator 101c, and the "0" level of the two-value signal is output when the absolute value [ S1 ] is out of the aforesaid range (Fig. 21 (c ) ), and it is smoothed by the low pass filter 101d so as to be output as the wave shape discriminating signal SWA (see Fig. 21 (d)).

[ 0050 ]

As shown in Fig. 22, when a rectangular wave W2 (Fig. 22(a)) is input into the wave shape detector 101, for example, an absolute value [ S2 ] of the rectangular wave W2 is output from the absolute value detector 101a and an average value [ Sa2 ] of the absolute

value [ S2 ] of the sinusoidal wave W2 is output from the low pass filter 101b (see Fig. 22 (b)).

Then, while the absolute value [ S2 ] is between values [ Sa2H ] and [ Sa2L ] within ± 20 % of the value of the average value [ Sa2 ], the "1" level of the 2-value signal is output from the comparator 101c, and the "0" level of the 2-value signal is output therefrom when the absolute value [ S2 ] is out of the above range (Fig. 22 (c)) to be output as the wave shape discriminating signal SWA after being smoothed by the low pass filter 101d (see Fig. 22 (d)).

[ 0051 ]

As a result, the wave shape detector 101 outputs a wave shape discriminating signal SWA of low signal level (the signal level is about 0.2 in Fig. 21 (d)) when a sinusoidal wave which the signal amplitude dynamically deviates from the average value of the amplitude. In contrast, when the rectangular wave which the signal amplitude does not deviate from the average value of the amplitude as a center, the wave shape discriminating signal SWA of high signal level (the signal level is about 0.85 in Fig. 22 (d)) is output therefrom. Further, the cut-off frequency of the low pass filter 101b is set at 50 Hz and the cut-off frequency of the low pass filter 101d is set at 25 Hz.

[ 0052 ]

Namely, the wave shape detector 101 outputs the wave shape discriminating signal SWA which the signal level varies depending on a ratio of the period where the amplitude of the input audio signal is within a range of ± 20 % of the amplitude average value as a center. By virtue of this, the nearer the signal level of the wave shape discriminating signal SWA approaches to about 0.2, the more the wave shape of the audio signal approximates the sinusoidal wave; the nearer the signal level approaches to about

0.85, the more the wave shape of the audio signal approximates the rectangular wave. Further, an ideal rectangular wave perfectly presents 1.

Herein, if it is the Y modulation method, the signal level of the wave shape discriminating signal SWA is 0.4 or less; if it is the Q modulation method, the header portion of the audio signal is almost perfectly a sinusoidal wave so that it becomes 0.3 or less and also it becomes 0.7 or more except the header portion; and if it is the P modulation method, it becomes 0.8 or more, therefore, the signal level of the wave shape discrimination signal SWA can discriminate the modulation method.

[ 0053 ]

③ The configuration of the level detectors 102 and 106 in the detecting system 100

Next, the internal configurations of the level detectors 102 and 106 will be explained with reference to Fig. 23. Since the level detectors 102 and 106 have the same configurations, the explanation will be made on the level detector 102 only. In this example, the level detector 102 comprises an absolute value detector 102a, a low pass filter (LPF) 102b, a comparator 102c, and a one-shot multi-vibrator 102d. Herein, the cut-off frequency of the low pass filter 102b is set at about 100 Hz, for example.

[ 0054 ]

In the level detector 102, the absolute value detector 102a outputs the absolute value [ S ] of the audio signal which is input from the right channel, and the lower frequency component of the output signal is input into the comparator 102c through the low pass filter 102b. The comparator 102c compares the output signal from the low pass filter 102b with the predetermined level, and outputs the "1" level of the 2-value signal when it is at the predetermined level or more, while outputs the "0" level of the 2-value signal when it is at the predetermined level. Herein, the threshold value of the

comparator 102c is set at an extremely small value, and the "1" level of the 2-value signal is output when the audio signal which is not no-tone is input. When a rise of the output signal of the comparator 102c is detected, the one-shot multi-vibrator 102d outputs the "1" level of the 2-value signal as the level detecting signal SL, or when a fall of the output signal of the comparator 102d is detected, the level detecting signal SL is caused to go down at the "0" level of the 2-value signal after the predetermined period lapses. Namely, the level detector 102 successively outputs the level detecting signal SL at the "1" level when the audio signal which is not no-tone is input, and when the audio signal is not successively input (the audio signal of the no-tone is successively input), namely, the no-signal state (no tone state) is detected for a predetermined period of time, the level detecting signal SL of the "0" level is output.

[ 0055 ]

④ Configuration of demodulator 110 in the detecting system 100

Next, the internal configuration of the demodulator 110 shown in Fig. 18 will be explained with reference to Fig. 24. In the example shown in the block diagram in Fig. 18, the demodulator 110 comprises an amplifier 110b, a sinusoidal wave generator 110c, a multiplier 110d and a low pass filter 110e. In this configuration, the carrier signal which is input from the Carrier terminal 110a is amplified by the amplifier 110b and thereafter is input into the multiplier 110d. Into the multiplier 110d is input a sinusoidal wave signal which is generated by the sinusoidal wave generator 110c and has the same frequency (in this case 6.3 kHz) as the carrier signal, and the output of the amplifier 110b and the output of the sinusoidal wave generator 110c are multiplied thereby in the multiplier 110d. The multiplied result which is output from the multiplier 110d is input into the 14 th order cosine roll-off low pass filter 110e having an fc = 6.3 kHz to be filtered and a base band

signal component is extracted. The base band signal extracted from the low pass filter 110e is output from the Base terminal 110f.

[ 0056 ]

⑤ Configuration of Y detector 111 in the detecting system 110

Next, the internal configuration of the Y detector 111 will be explained with reference to Fig. 25. In the example illustrated in the block diagram in Fig. 25, the Y detector 111 comprises a zero-cross detector having hysteresis 111b and an interval discriminator 111c. In this configuration, the base band signal which is input from the Signal terminal 111a is input into the zero-cross detector having hysteresis 111b. The zero-cross detector having hysteresis 111b has a configuration to detect the change in level of the base band signal ("0" —> "1" or "1" —> "0") and judges whether the signal change from the positive to the negative or from the negative to the positive takes place in the input signal over a predetermined half value from a center value (zero level) of the wave shape for every predetermined sampling cycles, and outputs the signal of "1" level upon the generation and outputs the signal of "0" level when it is not generated. The output signal from the zero-cross detector having hysteresis 111b is output from the Trigger terminal 111d as it is and is input into the Trigger terminal of the interval discriminator 111c.

[ 0057 ]

The interval discriminator 111c includes a first counter which increments a count value one by one for every predetermined sampling cycles and which is reset every time when the signal level of the Trigger terminal becomes "1", and judges whether or not the time interval of the level change of the input signal matches the inherent time period of the Y modulation method based on an count value (however, the count value before the reset)

every time when the signal level in the Trigger terminal becomes "1". Namely, the count value represents a time interval from when the signal level in the Trigger terminal becomes "1" in the previous timing to when the signal level in the Trigger terminal becomes "1" this time so that it is judged that the time interval corresponds to the inherent time period of the Y modulation method when the count value is a predetermined value (a value within a predetermined range). The interval discriminator 111c further includes a second counter which decrements the count value one by one when the time interval of the level change in the input signal is judged that it corresponds to the inherent time period of the Y modulation method and which is reset to a predetermined initial value when it is not the inherent time period, and outputs the "1" level from the Status terminal when the second counter value becomes zero. Namely, there is output from the Status terminal a signal of the "1" level, namely, representing the that the Y modulation method is detected, when a state that the time period fulfills a predetermined condition for every input of the Trigger signal is successively established for a number of times which is set as an initial value.

[0058]

Specifically, assuming that the sampling frequency is 22.68 $\mu$ s, the interval discriminator 111c is operated to judge the edge interval of the base band signals corresponds to 317.5 X n $\mu$ s if the remainder of the count value of the first counter at that timing is 13 by dividing by 14 (22.68 $\mu$ s X (14n – 1) = (317.5 n – 22.68 $\mu$ s ); if the remainder of the count value is 0 by diving by 14, namely, simply dividable by 14 (22.68 $\mu$ s X 14n; or if the remainder of the count value is 1 by diving by 14 (22.68 $\mu$ s X (14n + 1 ) = (317.5 n + 22.68 $\mu$ s ) (n is natural number) when the signal level in the Trigger terminal becomes "1". When the initial value of the second counter upon reset is set to 8, for example, the counter value of the second counter is decremented one by one when the

remainder of the count value of the first counter is 13 by dividing by 14 or it is 0 or 1 when the count value is 14 or more and such condition successively fulfills for eight times and the counter value of the second counter becomes "0" to judge that the Y modulation method is detected.

[ 0059 ]

⑥Configuration of the P detector 103 and Q detector 107 in the detecting system 100

The configurations of the P detector 103 and the Q detector 107 are basically the same as that of the Y detector 111 shown in Fig. 25, and respective detectors are operable at the same sampling timing. However, since the audio from the right and left channels which are input are input into the zero-cross detector having hysteresis (the reference numeral 111b in Fig. 25) through the terminals 100a and 100b in Fig. 25 as they are instead of the terminal 111a in Fig. 25, the detection levels are set different or the judgment criteria in the interval discriminator (the reference numeral 111c in Fig. 25) and the setting of the initial values or the like are set different. For example, setting the sampling cycle as 22.68 $\mu$ s as similar to the above, the interval discriminator in the P detector 103 is set to judge that the edge interval of the base band signal corresponds to 129.5 $\mu$ s and 259 $\mu$ s when the count value of the first counter, which counts it up for every sampling cycle when the signal level of the Trigger terminal becomes "1", is equal to either of 5, 6, 11 or 12. For example, 16 is adopted as the initial value upon reset of the second counter which counts down every time when the "1" level signal is input into the Trigger terminal. As similarly, if the sampling cycle is set at 22.68 $\mu$ s which is the same as in the above, the interval discriminator in the Q detector 107 is set to judge that the edge interval of the base band signal corresponds to 145 $\mu$ s, 290 $\mu$ s, 581 $\mu$ s and 3855 $\mu$ s when the count value of the first counter, which counts it up for every sampling cycles when the signal level of the

Trigger terminal becomes "1", is either case of 6, 7, 12, 13, 14, 26, 27, or a case that is equal to 166 or more and equal to 174 or less. For example, 16 is adopted as the initial value upon reset of the second counter which counts down every time when the "1" level signal is input into the Trigger terminal.

[ 0060 ]

⑦ A case that the interval discriminator of Y detector 111, P detector 103 and Q detector 107 in the detecting system 100 is made by employing program

Next, when the interval discriminator 111c in the Y detector 111 shown in Fig. 25 and the interval discriminator in the P detector 103 and the Q detector 107 are configured by employing a CPU (central processing unit) and program which is stored in a predetermined storage system, for example, each of routines by the CPU will be explained with reference to a flowchart shown in Fig. 26. However, in the flowchart shown in Fig. 26, a reference of "_x" or "_X" is attached to the ends of variables or fixed values used in the respective discriminators, respectively, so as to make them common in all of the interval discriminators in the Y detector 111, the P detector 103 and the Q detector 107. Accordingly, "_x" is replaced with "_y" in the Y detector 111; "_x" is replaced with "_p" in the P detector 103 and "_x" is replaced with "_qp" and "_qc" in the Q detector 107 to apply them in respective detectors, and as similarly, a capital letter of "X" attached to the constant values is replace with "Y", "P" or "Q" to modify the reading as similarly. Further, the variable cnt_qp in the P detector 103 is a variable when an interrupt routine is executed at an interrupt cycle corresponding to the edge interval of the sinusoidal wave at the header portion of the audio signal, and the variable cnt_qc is a variable when an interrupt routine is executed at an interrupt cycle corresponding to the edge interval of the base band signal of the audio signal.

[ 0061 ]

Fig. 26(a) is a flow for initializing each of variables in the interval discriminators configured as an interrupt routine shown in Fig. 26 (b). In Fig. 26, a variable mes_x is for holding a counter value in a counter for time measurement (the above first counter) having an interrupt cycle of 22.67 $\mu$ s, and a variable cnt_x is for holding a counter value in a counter for accumulating a number of succession (the above second counter). First, an interrupt disabling routine is executed (S 101) in an initializing (Reset) routine shown in Fig. 26 (a); a variable Status (corresponding to the Status terminal) is reset (S 102); a variable cnt_x is set at 0 (S 103); a variable mes_x is set at 0 (S 104), and an interrupt enabling routine is executed (S 105). On the other hand, it is judged if there is the Trigger input or not in the interrupt routine for every 22.67 $\mu$ s shown in Fig. 26 (b) (S 201); 1 is added to the variable mes_x if not (S 206) to finish an interrupt routine, and it is judged whether the value of the variable mes_x is an inherent value or not if any (S 202) or not. The inherent value means that, for the case of the Y detector 111, the remainder is "13" upon being divided by "14", or that "0" or "1" when the counter value is "14" or more.

In the step S 202, the value of the variable mes_x is an inherent value, 1 is added to the variable cnt_x (S203), and 1 is subtracted from the variable cnt_x when the variable mes_x is not the inherent value (S204). Following that, the variable mes_x is initialized with 0 (S 205); and 1 is added to the variable mes_x (S 206) to finish the interrupt. On the other hand, if the value of the variable mes_x is an inherent value in the step S 202, the output Curr is set with true ("1") (S 203), and it is judged whether or not the variable cnt_x is equal to "0" or not (S 204). On the other hand, predetermined bits are set in the variable Status when the variable cnt_x is not equal to "0" in the step S 204 (S 205), and when the variable cnt_x is "0" in the step S 204, predetermined bits are set in the variable

Status (S 205) to execute the above mentioned processes in S 206 and thereafter.

[ 0062 ]

⑧ Configuration by employing program in A detector 108b in the total discriminating system 108 in the detecting system 100

Next, routines executed by the CPU when the configuration of the A detector 108b shown in Fig. 18 is realized by the CPU and program stored in a predetermined storage system will be explained with reference to a flowchart shown in Fig. 27. Fig. 27(a) is a flow for initializing each of the variables in the A detector 108b configured as the interrupt routine shown in Fig. 27 (b). The variable cnt_a in Fig. 27 is for holding the counter value in the counter for measuring time with an interrupt cycle of 22.67 $\mu$ s. A counter for automatic count-up for a predetermined period of time is used as a timer Timer.

[ 0063 ]

In the initialization (Reset) routine in Fig. 27(a), the interrupt disabling routine is executed (S 301); a variable Status (corresponding to the Status terminal) is reset (S 302); a constant value COUNT_A (for example, 32) is set in the variable cnt_a (S 303); the timer Timer starts to count up (S 304); and an interrupt is enabled (S 305). On the other hand, in the interrupt routine shown in Fig. 27 (b) for every 22.67 $\mu$ s, it is judged whether audio signals are input into the terminals 100a or 100b or not (whether it is at the no-sound state or not) (S 401). When there is no input (namely, the no-sound state), the timer Timer is reset (S 408); the constant value COUNT_A is set in the variable cnt_a (S 409); and it is judged whether the timer Timer executes the count-up for a predetermined time period (for example, the amount of 4000 counts) or not (S 410). In this case, since it is immediately after the reset in the step S 408, the judgment in step S 410 is "N" so that the interrupt routine is finished.

[ 0064 ]

If it is judged that the audio signal is input thereinto in the step S 401, it is judged whether there is the "1" level input in the Trigger terminal (S 402) or not. If there is not an input of "1" level in the Trigger terminal in the step S 402, it is judged whether the timer Timer executes the count-up for a predetermined period of time in the step S 410 or not. When the timer Timer executes the count-up for a predetermined period of time, a predetermined bits are set in the variable Status (S 411); and an interrupt routine is finished after a reset by stopping the timer Timer (S 412). On the other hand, when it is judged that there is the input of "1" level into the Trigger terminal in the step S 402, it is judged whether there is the input of "1" level in the Audio terminal or not.in the step S 403. If there is not the input of "1" level in the Audio terminal in the step S 403, steps after the step S 410 are executed after setting the constant value of COUNT_A in the variable cnt_a (S 407).

[ 0065 ]

On the other hand, if there is the input of "1" level in the Audio terminal in the step S 403, it is judged whether the variable cnt_a is not equal to "0" or not in step S 404. If the variable cnt_a is judged not to be equal to "0" in the step S 404, the variable cnt_a is decremented by 1 (S 406) and steps after the step S 410 will be executed. If the variable cnt_a is equal to "0" in the step S 404, a predetermined bits are set in the variable Status (S 405) to execute the processes after the step S 410.

[ 0066 ]

⑨ Modulation method discrimination table

Fig. 28 is a drawing to illustrate a modulation method discrimination table which the logical calculating portion 180 refers upon discrimination of the modulation method.

Herein, a variable wav_1 is a value representing an output of the wave shape discriminator 101 (signal level value of the wave shape discriminating signal) where the audio signal is input from the left channel, and a variable wav_r is a value representing an ouput of the wave shape discriminator 105 (signal level value of the wave shape discriminating signal) where the audio signal is input from the right channel. A variable cnt_y is an output value of the Y detecting portion 104; variables cnt_qp and cnt_qc are output values of the Q detector 107; and a variable cnt_p is an output value from the P detector 103. Then, the conditions which each of the variables have to be fulfilled are recorded for every modulation methods. Each of the values represented by "TH_" in the header portions are parameters previously set by inventors.

Accordingly, the logical calculating portion 108a in the total discriminating portion 108 can discriminate the modulation method of the input audio signal based on the output values from the wave shape detectors 101 and 105, level detectors 102 and 106, Y detecting portion 104, P detector 103 and Q detector 107 by referring to the modulation method discriminating table, and it is made to detect whether the input audio signal is an audio signal or not. Further, when a period where nothing is output from each of the detectors continues for a predetermined period of time (for example, 4 seconds) or more, it is judged as a time-out to judge it as the audio signal.

[ 0067 ]

3-2. Details of demodulator 30A

The demodulator 30A executes the demodulation processes corresponding to the modulation method judged by the detecting system 100 to generate MIDI signals from the audio signals. In Fig. 1, the demodulation process is illustrated in a hardware manner executed by the demodulator 30A when the judgment that the audio signal which is read

out from the recording medium 22 is acquired by the Y modulation method of the A company specification is made by the detecting system 100. As shown in Fig. 1, construing the demodulation process in this case from a hardware point of view, said demodulation process comprises a demodulation module 31 and a Data ——> MIDI conversion module 32.

[ 0068 ]

The demodulation module 31 extracts clock signals synchronized with each bits of the MIDI data or character synchronization signals from the audio signals by the method corresponding to the Y modulation method, and each bits of the Nibble stream data made of MIDI data or synchronization signals are demodulated in synchronization with the clock signals. . When the modulation method for generating the audio signal is the Y modulation method employing the 16-value DPSK, the Nibble stream data demodulated by the demodulation module 31 is input into the modulation module 32 to make the character synchronization, and the MIDI data having a bit length of multiple of 4 bits are restored to be transferred to external application or the MIDI data reproducing system

[ 0069 ]

3-2-1. Specific example of demodulation module 31

Next, the configuration of the demodulation module 31 shown in Fig. 1 will be explained with reference to Fig. 29 to Fig. 34. Fig. 29 is a block diagram illustrating the configuration of a portion of demodulation by the 16-value DPSK in the demodulation module 31 shown in Fig. 1. Accordingly, the signal representing the kind of modulation method which is supplied from the detecting system 100 is formed to function upon indicating the 16-value DSPK. An audio signal, which is input from the audio recording system 10 as the demodulation signal, is input from an input terminal 311 and is input into

a signal input terminal (312b) of a synchronization demodulation circuit 312. The cosine wave component and the sinusoidal wave component of an oscillation signal which is output from a PLL (Phase Lock Loop) circuit 315 are input into the synchronization demodulation circuit 312 from a cosine wave component input terminal (312a) and a sinusoidal wave component input terminal (312c), respectively. The synchronization demodulation circuit 312 outputs the real part component and the imaginary part component of the input modulated signal from a real part component output terminal (312i) and an imaginary component output terminal (312j), respectively, based on these input signals. Both of the real part component and the imaginary part component of the input modulated signal which is output from the synchronization demodulation circuit 312 are input into an orthogonal coordinate —> polar coordinate transformation circuit 313 and a trigger signal generator 314, respectively.

[ 0070 ]

The orthogonal coordinate —> polar coordinate transformation circuit 313 transforms the orthogonal coordinate data into the polar coordinate data based on the real part component and the imaginary part component of the input modulated signal which is output from the synchronization demodulation circuit 312 at synchronized timings with trigger signals which are output from the trigger signal generator 314 to be output as an angle data ranging from 0 to $2\pi$ from an angle output terminal (313h), and outputs an error component upon dividing the angle data into 16 from an error component output terminal (313i). The trigger signal generator 314 generates trigger signals for determining synchronization timings based on the real part component and the imaginary part component of the input modulated signal which is output from the synchronization demodulation circuit 312 to be output from a trigger signal output terminal (314k).

[ 0071 ]

The angle data which is output from the orthogonal coordinate —> polar coordinate transformation circuit 313 is input into a 16 DPSK unmap (un-mapping) circuit 316 and the angle information is converted into 4 bit digital data to be output at a synchronized timing with the trigger signal which is output from the trigger signal generator 314. The error data which is output from the orthogonal coordinate —> polar coordinate transformation circuit 313 is input into the PLL circuit 315 and the PLL oscillation circuit generates an alternating current waveform having a frequency of which a carrier frequency is corrected based on the error data so as to output the cosine wave component and the sinusoidal wave component thereof.

[ 0072 ]

Next, the configuration of the synchronization demodulation circuit 312 shown in Fig. 29 will be explained with reference to Fig. 30. The synchronization demodulation circuit 312 is made by an amplifier 312d, multipliers 312e and 312f, a cosine roll-off filter 312g for real number (R) and a cosine roll-off filter 312h for imaginary number (I). The modulated signal which is input from the input terminal 312b is amplified in the amplifier 312d, and is input into the multiplying circuits 312e and 312f thereafter to be multiplied by the cosine component which is input from the input terminal 312a and to be multiplied by the sinusoidal component which is input from the input terminal 312c, respectively. The outputs of the multiplying circuit 312e and the multiplying circuit 312f are input into the cosine roll-off filter 312g and the cosine roll-off filter 312h, respectively. The cosine roll-off filter 312g and the cosine roll-off filter 312h cut off the band widths of the base bands for the input signals with a roll-off ratio $\alpha = 1.0$, respectively, and extract the real part component and the imaginary part component so as to output the extracted results

from the output terminal 312i and the output terminal 312j, respectively.

[ 0073 ]

Next, the configuration of the orthogonal coordinate —> polar coordinate transformation circuit 313 will be explained with reference to Fig. 31. The orthogonal coordinate —> polar coordinate transformation circuit 313 shown in Fig. 31 comprises an orthogonal coordinate —> polar coordinate transformer 313c, a multiplying-and-dividing circuit 313d, a modulo function circuit 313e, an adding-and-subtracting circuit 313g, and a constant number generator 313f.

[ 0074 ]

The orthogonal coordinate —> polar coordinate transformer 313c transforms coordinate data in the orthogonal coordinate system represented by the real part component which is input from the input terminal 313a and the imaginary part component which is input from the input terminal 313b into coordinate data in the polar coordinate system, and phase angle data of the modulated signal which is acquired by the transformation is output as the angle data from the output terminal 313h and is also input into the multiplying-and-dividing circuit 313d. The multiplying-and-dividing circuit 313d operates the multiplication of the phase angle data of the modulated signal which is input from the orthogonal coordinate —> polar coordinate transformation circuit 313 by 16 / ($2\pi$) to convert it into numerical data ranging from 0 to 16. The modulo function circuit 313e calculates decimal fraction of the input data from the multiplying-and-dividing circuit 313d to output it therefrom. The adding-and-subtracting circuit 313g subtracts 0.5 from a numerical value of decimal fraction which is input from the modulo function circuit 313e so as to output the operation result from the error data output terminal 313i. In such a way, the processing of degenerating the symbol information by multiplying the phase by

16 and creating modulo thereof to extract the error is generally known as a frequency multiplication method.

[ 0075 ]

Next, the configuration of the 16 DPSK unmap circuit 316 will be explained with reference to Fig. 32. The 16 DPSK unmap circuit 316 comprises a multiplying-and-dividing circuit 316b, a delay circuit 316c, an adding-and-subtracting circuit 316d, a modulo function circuit 316g and a gray code reverse conversion circuit 316e. The multiplying-and-dividing circuit 316b executes an operation of multiplying the angle data representing a value within 0 to 2 $\pi$ which is input from the orthogonal coordinate $->$ polar coordinate transformation circuit 313 by 16 / (2 $\pi$) to be converted into the numerical data of 0 to 16. The adding-and-subtracting circuit 316d subtracts the angle data which is delayed by the delay circuit 316c with one data from the angle data representing the absolute phase which is output from the multiplication-and-dividing circuit 316b based on the trigger signal supplied from the trigger signal generator 314 to execute a processing for converting the absolute phase value into a relative phase value. The modulo function circuit 316g outputs the remainder of the division of the relative phase value by "16". The gray code reverse conversion circuit 316e outputs the Nibble data through the reverse conversion of the gray code based on the output data of the modulo function circuit 316g.

[ 0076 ]

Next, the configuration of the trigger signal generator 314 will be explained with reference to Fig. 33. The trigger signal generator 314 comprises an input terminal 314a for inputting a signal of the real number component supplied from the synchronization demodulation circuit 312, an input terminal 314b for inputting a signal of the imaginary

number component, a delay circuit 314c for one data, an adding-and-subtracting circuit 314d, an absolute value circuit 314e, a threshold value generating circuit 314f, a comparator circuit 314g, a rising edge detecting circuit 314h, a sampling clock generating circuit 314i, a counter circuit 314j, and an output terminal 314k for the trigger signal. The adding-and-subtracting circuit 314d subtracts a value delayed by the delay circuit 314c with one data from the real number component which is input from the input terminal 314a to supply the subtracting result to the absolute value circuit 314e. The absolute value circuit 314e outputs an absolute value of the adding-and-subtracting circuit 314d. The comparator circuit 314g compares the output of the absolute value circuit 314e with a predetermined threshold value which is output from the threshold value generating circuit 314f to cause the signal level of the output signal to go up when the absolute value circuit 314e exceeds the threshold value. The rising edge detecting circuit 314h outputs a reset signal to the counter circuit 314j when a rising edge is detected in the output signal from the comparator circuit 314g. The counter circuit 314j is an up-counter (which repeatedly counts 0 to 6) having a counting cycle of 7 by dividing a sampling frequency of 44100 kHz for the audio signal of the recording medium 22 by a carrier frequency of 6300 kHz, and causes the output signal of the rising edge detecting circuit 314h to be input into a reset input (RST) as the reset signal, executes a counting operation based on a clock signal of 44100 kHz which is input into a clock input (CLK) from the sampling clock generating circuit 314i, and outputs an output signal (Hit) representing the coincidence at the middle point of the counting period as a trigger signal from the output terminal 314k.

[ 0077 ]

Next, the configuration of the PLL circuit 315 will be explained with reference to Fig. 34. The PLL circuit 315 comprises an input terminal 315a for inputting error signal

pulse stream which is output from the orthogonal coordinate —> polar coordinate transformation circuit 313, a loop filter 315b for filtering the signal which is input into the input terminal 315a, a loop gain amplifier 315c for amplifying the output level of the loop filter 315b, a predetermined value generating circuit 315d for outputting data of a value corresponding a carrier frequency 6300 Hz, an adder circuit 315e for adding the output of the loop gain amplifier 315c and the output of the predetermined value generating circuit 315d, a voltage control oscillator 315g for oscillating an oscillation signal having a frequency corresponding to an output value of the adder circuit 315f, an output terminal 315g for outputting the cosine component of the oscillation signal of the voltage control oscillator 315f, and an output terminal 315h for outputting the sinusoidal wave component. The loop filter 315b is a low boost filter (Low Boost Filter) having a cut-off frequency of $\omega c$ and outputs the frequency component having angular frequency $\omega c$ or larger in the input signal at a gain of 1 and amplifies the amplitude level of the frequency component having an angular frequency $\omega c$ or less at a gain of 1 or larger.

[ 0078 ]

The demodulation module 31 shown in Fig. 29 with the above explained configuration demodulates a demodulated signal which is input from the audio recording system 20 through 16 DPSK so as to supply the demodulated data to the Data —> MIDI conversion module 32.

[ 0079 ]

3-2-2. Specific example of Data —> MIDI conversion module 32

Fig. 35 is a block diagram showing an example of configuration of the Data —> MIDI conversion module 32 shown in Fig. 1 will be explained. A MIDI data converter 323 in the Data —> MIDI conversion module 32 converts the input demodulated data to

MIDI data to output it. A MIDI data conversion memory 324 stores program for this MIDI data conversion therein. The MIDI data converter 323 is regulated by the control program of which a flow is shown in Fig.36 to demodulate the original MIDI data. As shown in the drawing, this flow comprises “a standby routine for musical information” made by steps SB 1 to SB 6, “a standby routine for unit data for discrimination” made by steps SB 10 to SB 15, and “a standby routine for following unit data” made by steps SB 20 to SB 24. Hereunder, to make the content of the control program more easily understandable, the explanation will be made by using a specific example.

[ 0080 ]

( Specific example ) When Nibble stream data “ FF904F0FFF ” (data D1 to D10) are supplied to the MIDI data converter 323 (Fig. 37)

Said data corresponds to the one which the unit data “F” are attached to before and after “904F0F”. The MIDI data converter 323 executes the “standby routine for musical information” (steps SB 1 to SB 6) to find the unit data corresponding to the header data (MSN) of the original MIDI data to be demodulated. In the present specific example, the unit data “F” (data D1) is supplied first (step SB 2) and the MIDI data converter 323 ignores said unit data (step SB 4) since said unit data is “F” (step SB 3; YES).

[ 0081 ]

This discrimination is based on the fact that the entire MIDI data experiences the data conversion to avoid the header unit data from being “F” in the above mentioned data conversion table (Fig. 7). Thereafter, the MIDI data converter 323 stands by for the next unit data to be supplied (step SB 4). In the present specific example, the unit data “F” (data D2) is supplied next (step SB 2), however, the MIDI data converter 323 executes the control as similar to the above (steps SB 3 and SB 4) and ignores said unit data “F”.

[ 0082 ]

Subsequently, when the unit data “9” (data D3) is supplied (step SB 2), the MIDI data converter 323 discriminates that said unit data corresponds to the MSB of the original MIDI data since said unit data is not “F” (step SB 3; NO). The MIDI data converter 323 discriminates that the MSN of the original MIDI data is “9” (step SB 6) since said unit data is not also “C” (step SB 5; NO). This discrimination is based on the fact that the MIDI data of which MSN is other than “C” or “F” is not the object of the data conversion in the above mentioned data conversion table (Fig. 7).

[ 0083 ]

Thereafter, the MIDI data converter 323 executes the “standby routine for following data” (steps SB 20 to SB 24) to discriminate data following said MSB “9” and demodulates the MIDI data. In the specific example, the MIDI data converter 323 is supplied with the next unit data “0” (data D4) (step SB 20: YES), the MIDI data converter 323 discriminates that the LSN of the original MIDI data is “0” (step SB 21) by the value of said unit data. This discrimination is based on the fact that the data except the header data (MSN) of the MIDI data are not the object of the data conversion in the above mentioned data conversion table (Fig. 7). Namely, the MIDI data converter 323 discriminates that the MSN and LSN (status byte) of the original MIDI data is “90” at this stage. Then, the MIDI data converter 323 discriminates the length of the data byte following said status byte based on the determined value of the status byte. In this specific example, it discriminates that there are two data bytes following the status byte “90” (step SB 22).

[ 0084 ]

Thereafter, the MIDI data converter 323 discriminates supplied 4 unit data (data

D5 to D8) as two data bytes "4F" and "0F" (step SB 23) to demodulate a single MIDI data "904F0F" (step SB 24). The above is the content of the "standby routine for following unit data" and the MIDI data converter 323 executes the "standby routine for musical information" again thereafter to discriminate whether there is data corresponding to the header (MSN) of a subsequent MIDI data or not (step SB 2).

[ 0085 ]

Since all of the unit data supplied thereafter are "F" in the specific example (data D9 and D10), the MIDI data converter 323 executes said control for ignoring these unit data "F" (steps SB 3 and SB 4). Fig. 38 is a view to indicate the MIDI data which are output from the MIDI data converter 323. In the drawing, the dotted lines, show segments where MIDI data do not exist. In such a way, the MIDI data converter 323 original MIDI data from supplied successive unit data by executing the "standby routine for musical information", "standby routine for unit data for discrimination" and "standby routine for following unit data".

[ 0086 ]

Fig. 39 illustrates transitional states of three processes (the standby routine for musical information 1901, standby routine for unit data for discrimination 1902, standby routine for following unit data 1903) which the above explained MIDI data converter 323 executes.

[ 0087 ]

By virtue of this, in addition to a method for discriminating the modulation method of the audio signal by detecting edge intervals of the input audio signals and the edge intervals of the base band signals of the audio signals, the audio reproducing system 30 can precisely discriminate the modulation method by judging the wave shape of the

input audio signal so as to discriminate the modulation method of the audio signal based on the judgment result, and can accurately discriminate whether they are MIDI signals or audio signals. Further, the audio reproducing system 30 enhances the accuracy of the above mentioned discrimination further by detecting whether or not the audio signal is input into each of the channels in accordance with the modulation methods of each companies.

[ 0088 ]

Moreover, the present embodiment of the present invention is not limited thereto, and it is not limited to the DPSK of 16 values which is mentioned in the above for the Y modulation method, and it may be available to select other DPSK of multi-value more than 2 or to adopt other multi-value modulation methods. For example, when an 8 (= 23) -value DSPK is adopted, the unit data may be 3 bit length, and when a 4 (=22)-value DSPK is adopted, the unit data may be 2 bit length. The carrier frequency, the method of state transition and the setting of the constellation are not limited to the above and are properly modifiable.

[ 0089 ]

In the above mentioned embodiment, the case that the modulation method is discriminated by employing all of the wave shape of the modulated signal and the signal level and the edge intervals, however the present invention is not limited to this and the modulation method may be discriminated based on the wave shape of the modulated signal only and the combination thereof is arbitrary. In summary, it is sufficient to judge how much the modulated signal approximates the sinusoidal wave or the rectangular wave as a method of discriminating the wave shape of the modulated signal, and various methods such as a judging method by make a difference between the sinusoidal wave or the

rectangular wave and the modulated signal may be widely applied thereto.

[ 0090 ]

Further, since the present invention is not limited to the audio reproducing system for reproducing the MIDI signal and audio signal and can discriminate the modulated signal of various modulation methods, it is widely applicable to computers in electronic devices such as an image reproducing system, an electronic musical instrument or the like for executing modulation or demodulation by inputting the modulated signal of various modulation methods. The present invention may be applicable to a modulation method discriminating system to be installed in such kinds of electronic equipment. The program for discriminating the modulation method may be provided by a computer-readable information recording medium such as a magnetic recoding medium, optical recording medium, semiconductor memory or the like, and the above mentioned program may be provided through the network.

[ 0091 ]

[ EFFECTS OF THE INVENTION ]

Explained in the above, according to the present invention, the modulation method of the modulated signal acquired by modulating the MIDI signals or the like and a type of the modulated signal is allowed to be discriminated with high accuracy and it is available to easily comply with various modulation method with a single system

[ BRIEF DESCRIPTION OF THE DRAWINGS ]

[ Fig. 1 ] The block diagram showing the configuration of the audio recording system and an audio reproducing system serving as an embodiment of the present invention.

[ Fig. 2 ] The view of wave shape of the audio signal according to the Y

modulation method.

[ Fig. 3 ] Fig. 3 (a) is the view of wave shape of the header portion of the audio signal according to the Q modulation method, and Fig. 3 (b) is the view of wave shape of portions except the header portion.

[ Fig. 4 ] The view of wave shape of the audio signal according to the P modulation method.

[ Fig. 5 ] The view to illustrate the detail of the specification of the Y modulation method.

[ Fig. 6 ] The block diagram of the MIDI −> Data conversion module.

[ Fig. 7 ] The view to show the data conversion table employed in the MIDI −> Data conversion module.

[ Fig. 8 ] The view to show the data conversion table employed in the MIDI −> Data conversion module.

[ Fig. 9 ] The view to show the data conversion table employed in the MIDI −> Data conversion module.

[ Fig. 10 ] The view to show the data conversion table employed in the MIDI −> Data conversion module.

[ Fig. 11 ] The view to show the data conversion table employed in the MIDI −> Data conversion module.

[ Fig. 12 ] The view to show the data conversion table employed in the MIDI −> Data conversion module.

[ Fig. 13 ] The view to show the data conversion table employed in the MIDI −> Data conversion module.

[ Fig. 14 ] The view to show the constellation of the 16 DPSK signals in the present embodiment in a list.

[ Fig. 15 ] The view to show the spatial location of the constellation of the 16 DPSK signals.

[ Fig. 16 ] The block diagram to show the configuration of the modulation module.

[ Fig. 17 ] The block diagram to show the configuration of the detecting system.

[ Fig. 18 ] The block diagram illustrating peripheral configurations of the Y detecting portion, P detector, Q detector and A detector.

[ Fig. 19 ] The block diagram to show the configuration of the wave shape detector.

[ Fig. 20 ] The block diagram to show the configuration of the comparator of the wave shape detector.

[ Fig. 21 ] The view to explain the output of the wave shape detector when the sinusoidal wave is input.

[ Fig. 22 ] The view to explain the output of the wave shape detector when the rectangular wave is input.

[ Fig. 23 ] The block diagram to show the configuration of the level detector.

[ Fig. 24 ] The block diagram to show the configuration of the demodulator.

[ Fig. 25 ] The block diagram to show the configuration of the Y detector.

[ Fig. 26 ] The flowchart to show the flow of the routine by program

constituting the Y detecting portion, P detector and Q detector, and (a) is a flow of the initialization routine of the interrupt routine and (b) is a flow of the interrupt routine.

[ Fig. 27 ] The flowchart to show the flow of the routine by program constituting the A detector, and (a) is a flow of the initialization routine of the interrupt routine and (b) is a flow of the interrupt routine.

[ Fig. 28 ] The view to show the content of the modulation method discrimination table.

[ Fig. 29 ] The block diagram to show the configuration of the demodulation module.

[ Fig. 30 ] The block diagram showing the configuration of the synchronization demodulation circuit.

[ Fig. 31 ] The block diagram showing the configuration of the orthogonal coordinate —> polar coordinate transformation circuit.

[ Fig. 32 ] The block diagram showing the configuration of the 16 DPSK unmap circuit.

[ Fig. 33 ] The block diagram to show the configuration of the trigger signal generator.

[ Fig. 34 ] The block diagram to show the configuration of the PLL circuit.

[ Fig. 35 ] The block diagram of the configuration of the Data —> MIDI conversion module.

[ Fig. 36 ] The flowchart to show the process content the Data —> MIDI conversion module

[ Fig. 37 ] The view to show the process content in the Data —> MIDI conversion module.

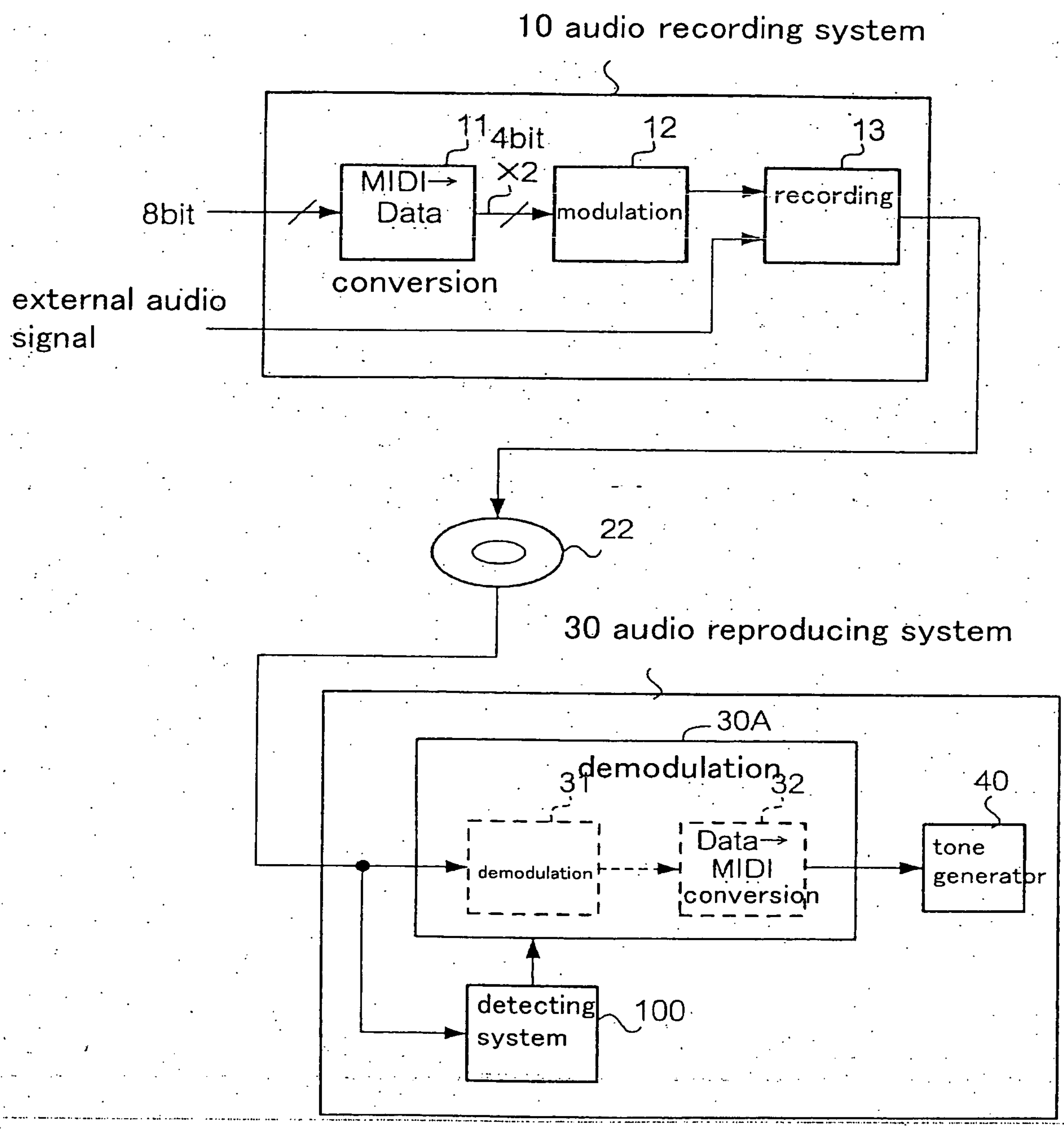
[ Fig. 38 ] The view to show the process content in the Data —> MIDI conversion module.

[ Fig. 39 ] The transitional state view of the Data —> MIDI conversion module.

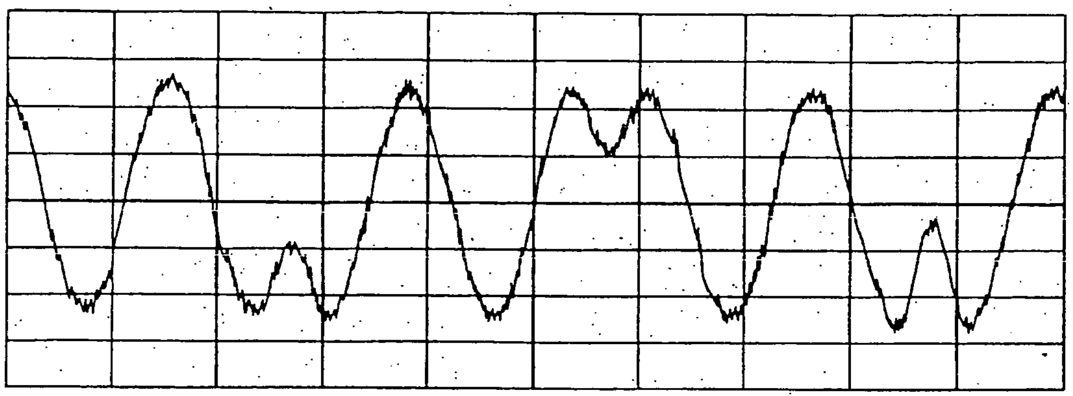
[ EXPLANATION OF REFERENCES ]

10 ... audio recording system 11 ... MIDI —>Data conversion module, 12 ... modulation module, 22 ... recording medium, 30 ... audio reproducing system, 30A ... demodulator, 31 ... demodulation module, 32 ... Data —> MIDI conversion module, 40 ... tone generator, 100 ... detecting system, 101, 105 ... wave shape detector, 102, 106 ... level detector, 103 ... P detector, 104 ... Y detecting portion, 107 ... Q detector, 108 ... total discriminating portion, 108a ... A detector, 108b ... logical calculating portion, 109 ... L / R separating circuit, 110 ... demodulator, 111 ... Y detector

[ DOCUMENT NAME ] DRAWING
[ Fig. 1 ]

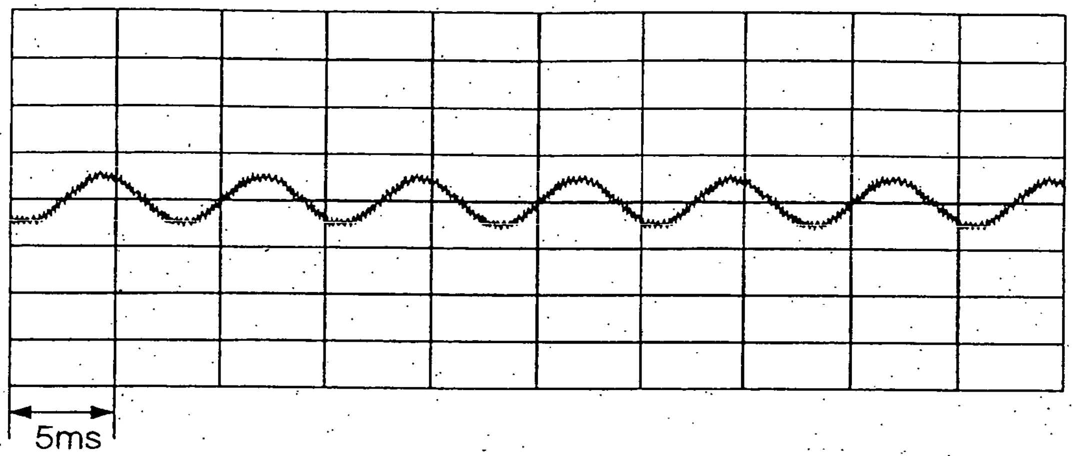


[ Fig. 2 ]

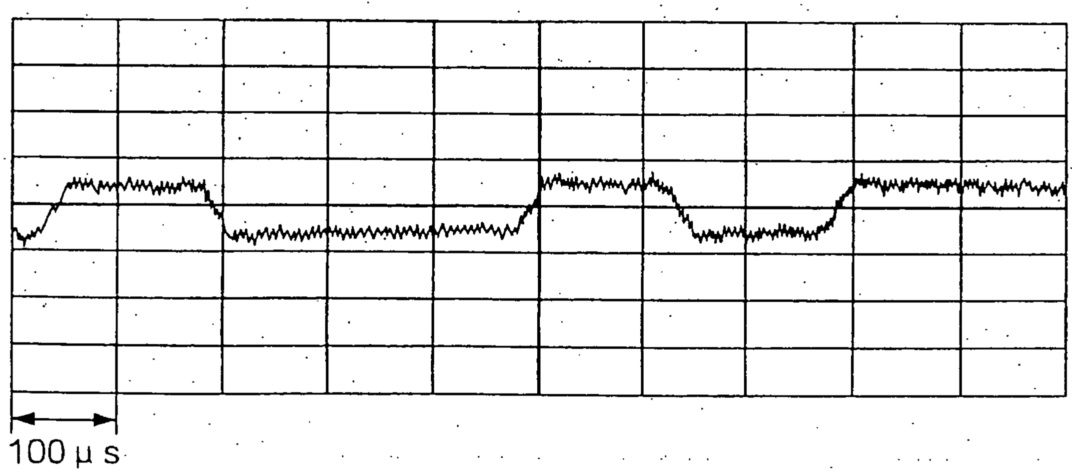


[ Fig. 3 ]

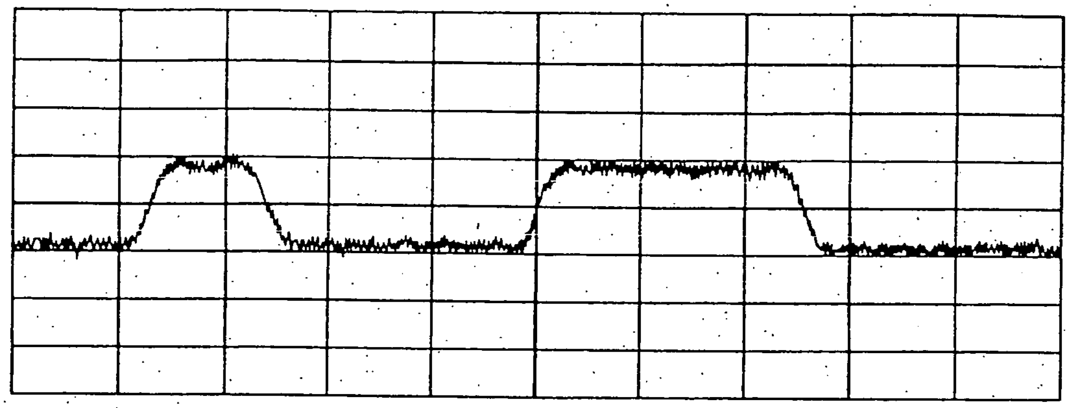
(a)




(b)



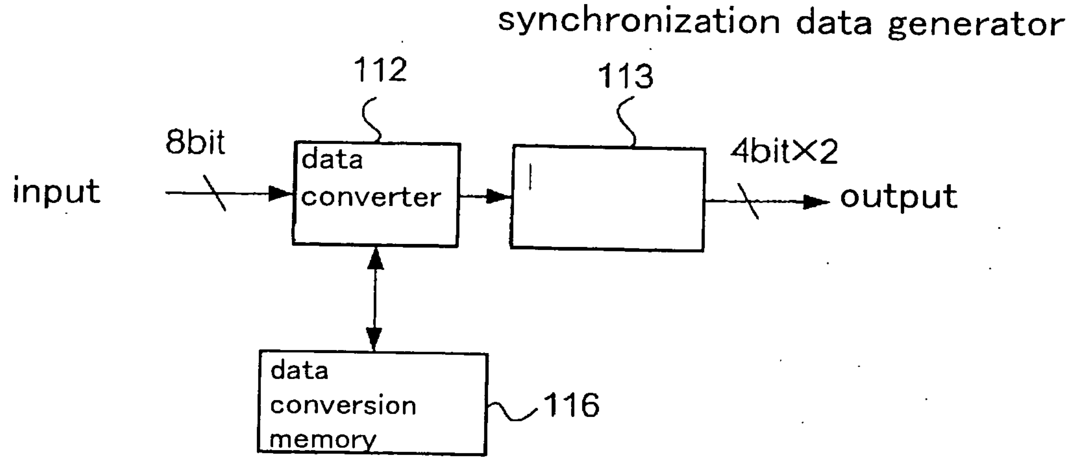
[ Fig. 4 ]



[ Fig. 5 ]

| item | specification | unit | Remarks |
|---|---|---|---|
| modulation waveform recording channel | R | Channel | Record audio signal in L channel |
| transmission speed | 25.2 | k bps (k bit/sec) | |
| Carrier frequency | 6.30 | kHz | |
| symbol speed | 6.30 | k baud (k symbol/sec) | |
| Bit number per Symbol | 4 | bit/symbol | |
| Encoding method | 4bit gray code | | |
| Modulation method | 16-value DPSK | | |
| Demodulation method | synchronized demodulation | | |
| Data synchronization | Sync Nibble | | |
| Delay time period for audio signal upon recording | 0 | msec | |
| Delay time period for audio signal upon reproducing | 500 | msec | |
| Recording level | -6.0~-12.0 | dB | The value for full range |
| No-signal period at a header of tune | 2.0 or more | sec | Time period necessary for synchronization |

[ Fig. 6 ]



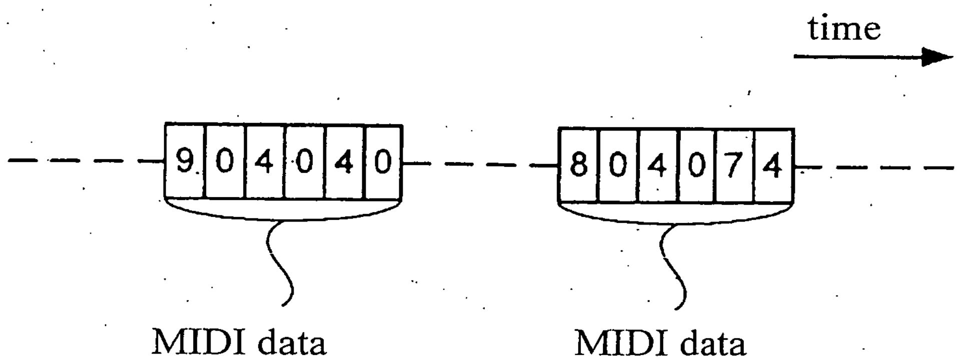

11: MIDI —> Data conversion module

[ Fig. 7 ]

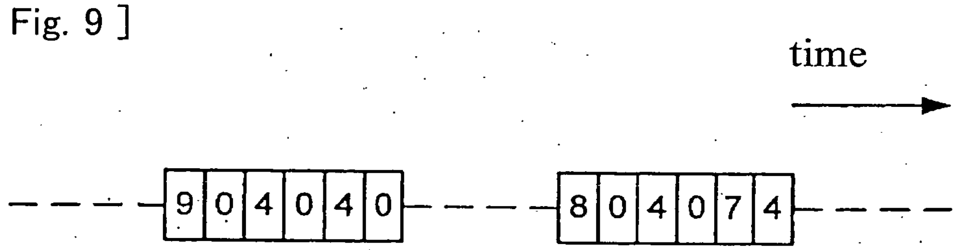
| status byte of MIDI data (hexadecimal representation) | data after conversion by data converter 12 ( hexadecimal representation ) | specific content in status byte (reference content) |
|---|---|---|
| C1 | C41 | program change for channel 0 |
| C2 | C42 | program change for channel 1 |
| C3 | C43 | program change for channel 2 |
| ⋮ | ⋮ | ⋮ |
| CF | C4F | program change for channel F |
| F0 | C0 | exclusive |
| F1 | C1 | time code (quater frame ) |
| F2 | C2 | song position pointer |
| F3 | C3 | song select |
| F4 | C54 | (not defined) |
| F5 | C55 | (not defined) |
| F6 | C6 | tune request |
| F7 | C7 | end of exclusive |
| F8 | C8 | timing clock |
| F9 | C9 | (not defined) |
| FA | CA | start |
| FB | CB | continue |
| FC | CC | stop |
| FD | CD | (not defined) |
| FE | CE | active sensing |
| FF | CF | system reset |

(no data conversion except the above)

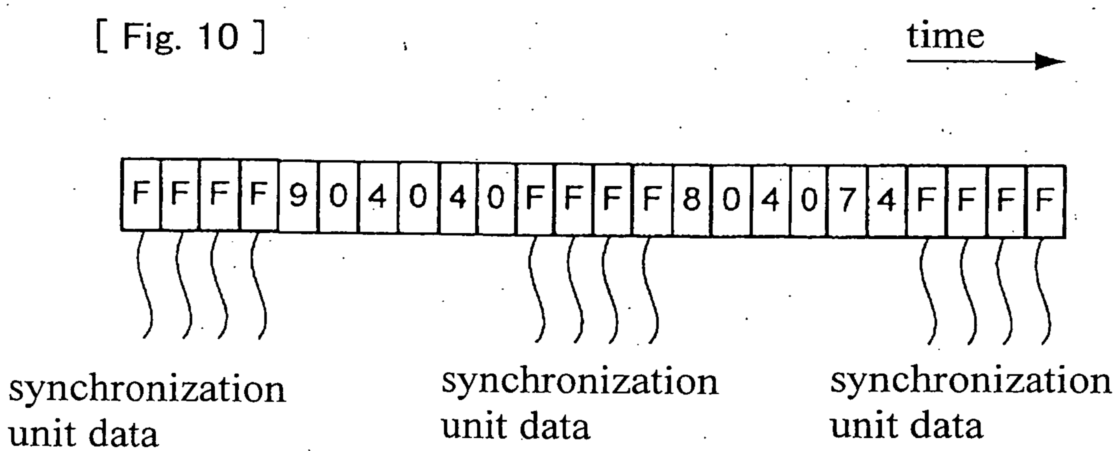
[ Fig. 8 ]



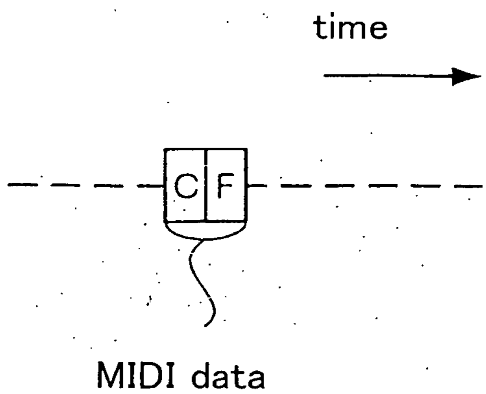

[ Fig. 9 ]



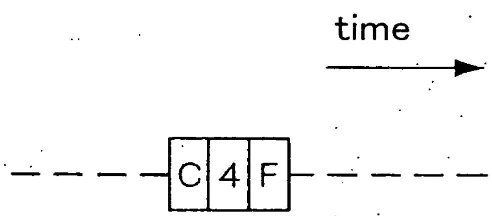

[ Fig. 10 ]



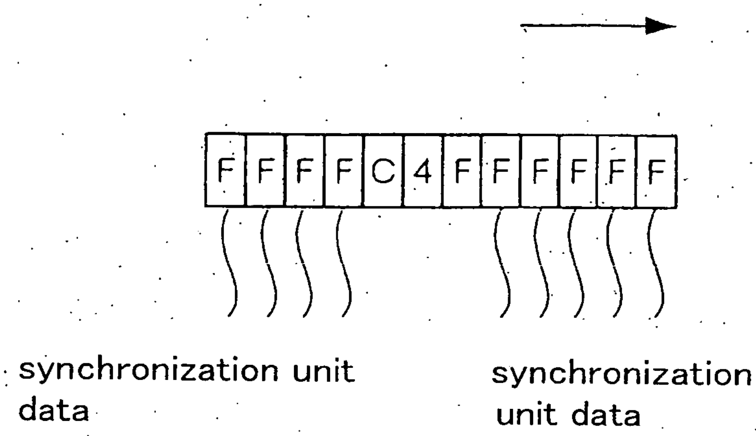
[ Fig. 11 ]




[ Fig. 12 ]



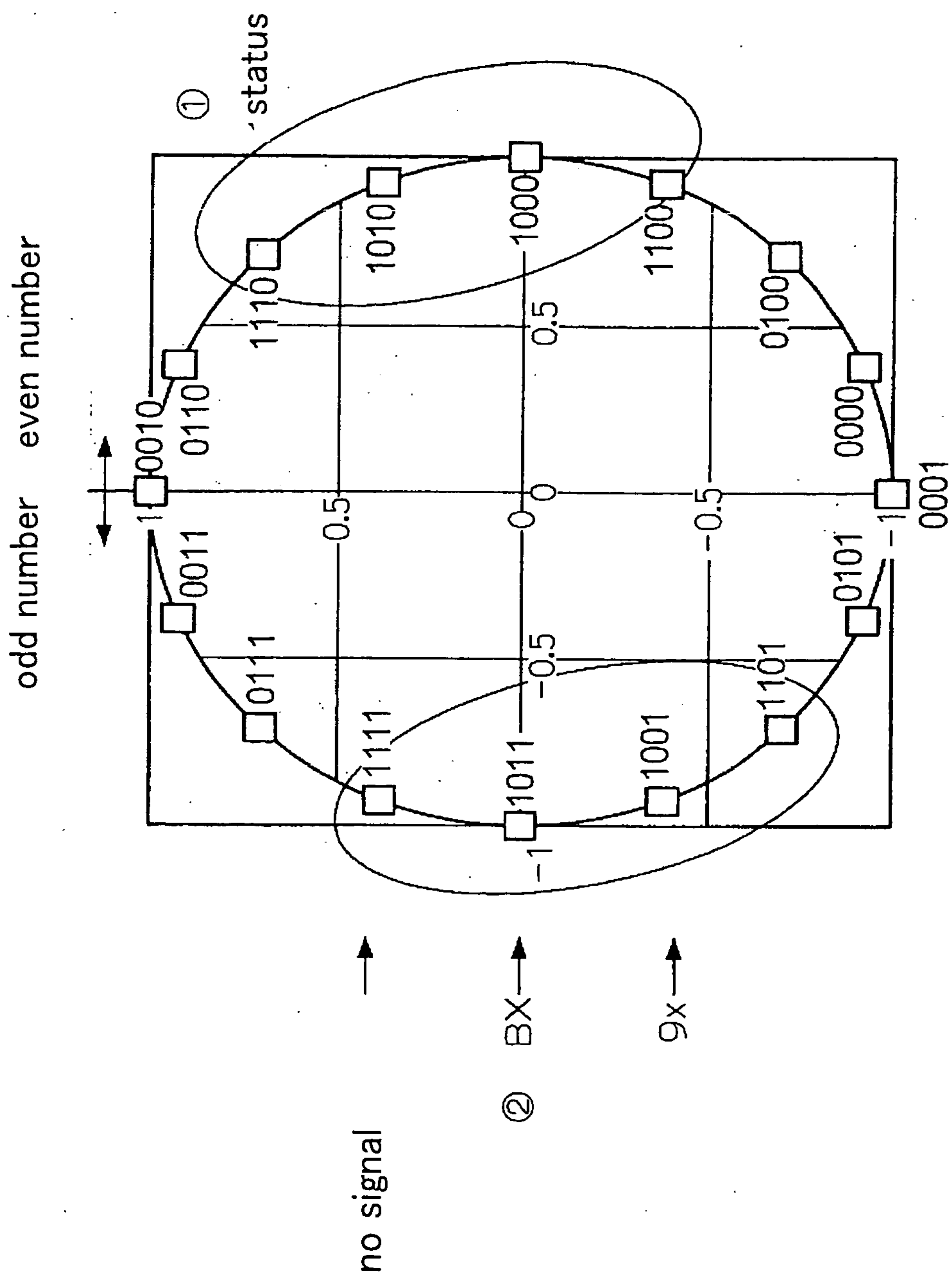
[ Fig. 13 ]


F F F F C 4 F F F F F F
synchronization unit data
synchronization unit data

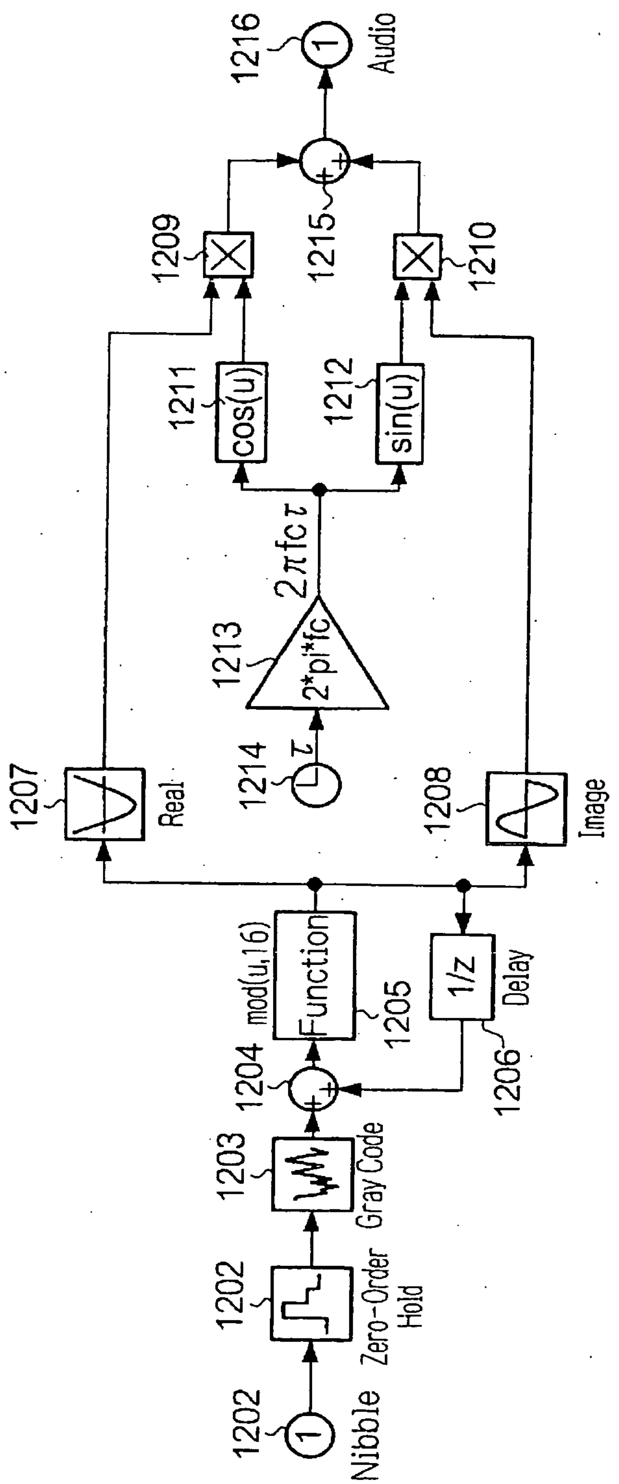
[ Fig. 14 ]

| Gray Code Data | [Dec] | phase [rad] | I-component | Q-component |
|---|---|---|---|---|
| 1000 | 0 | 0 | 1 | 0 |
| 1010 | 1 | 0.392699 | 0.92388 | 0.382683 |
| 1110 | 2 | 0.785398 | 0.707107 | 0.707107 |
| 0110 | 3 | 1.178097 | 0.382683 | 0.92388 |
| 0010 | 4 | 1.570796 | 0 | 1 |
| 0011 | 5 | 1.963495 | -0.38268 | 0.92388 |
| 0111 | 6 | 2.356194 | -0.70711 | 0.707107 |
| 1111 | 7 | 2.748894 | -0.92388 | 0.382683 |
| 1011 | 8 | 3.141593 | -1 | 0 |
| 1001 | 9 | 3.534292 | -0.92388 | -0.38268 |
| 1101 | 10 | 3.926991 | -0.70711 | -0.70711 |
| 0101 | 11 | 4.31969 | -0.38268 | -0.92388 |
| 0001 | 12 | 4.712389 | 0 | -1 |
| 0000 | 13 | 5.105088 | 0.382683 | -0.92388 |
| 0100 | 14 | 5.497787 | 0.707107 | -0.70711 |
| 1100 | 15 | 5.890486 | 0.92388 | -0.38268 |

[ Fig. 15 ]

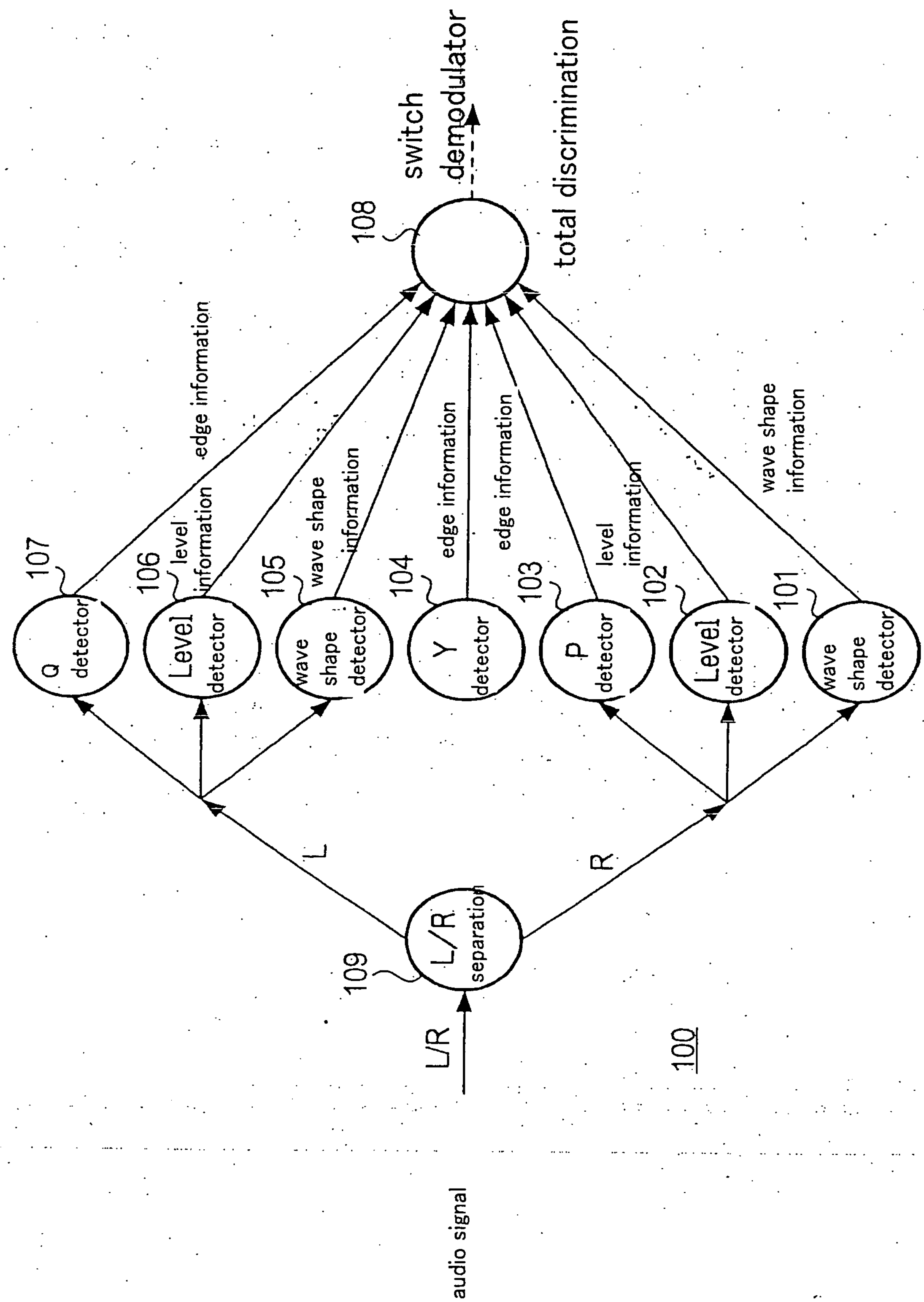

①
status
even number
odd number
1000
1010
1100
1110
0100
0010
0110
0000
0001
0011
0101
0111
1101
1111
1011
1001
0.5
-0.5
0
1
-1
no signal
8X
9x
②

[ Fig. 16 ]

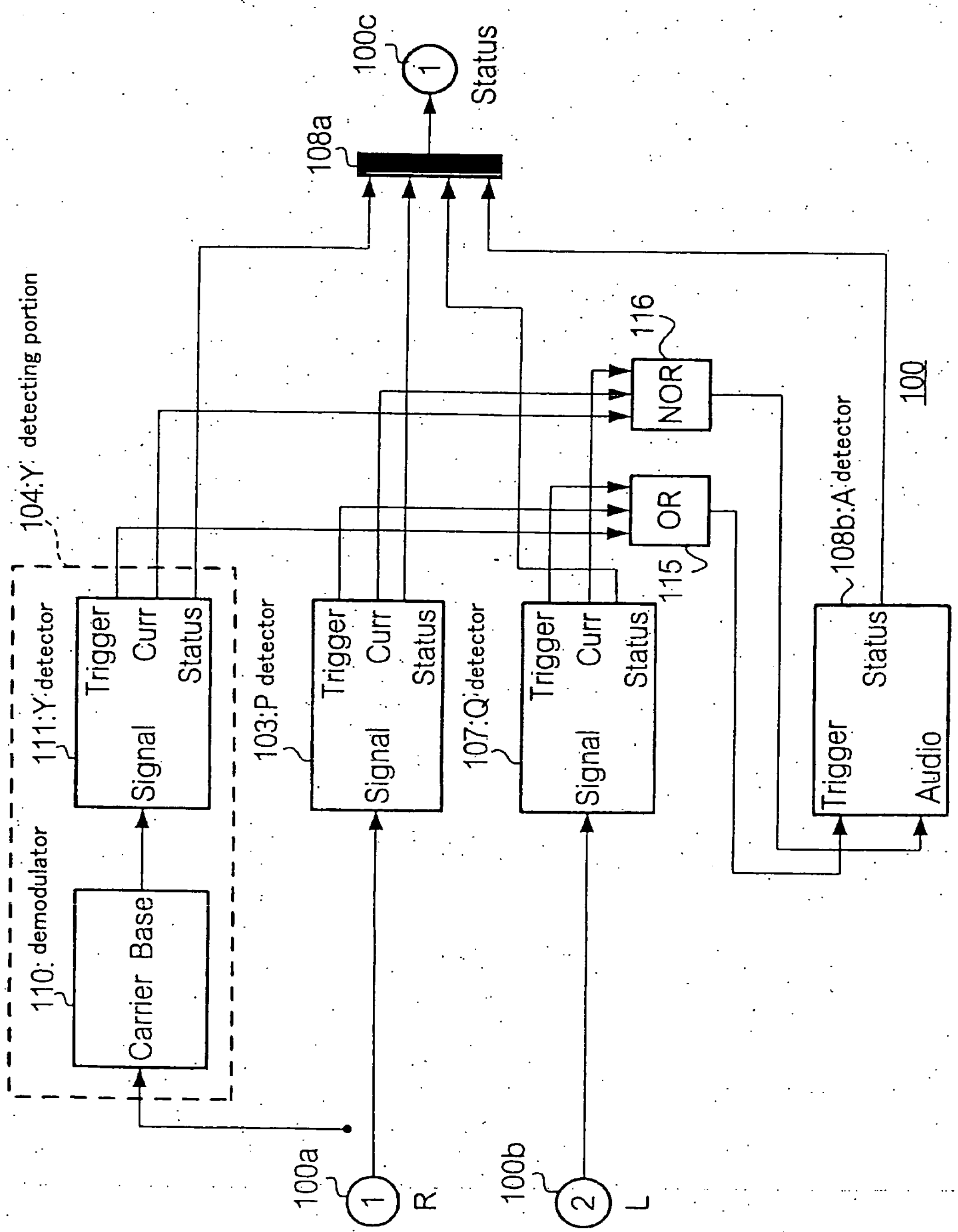

1202
1
Nibble
1202
Zero-Order Hold
1203
Gray Code
1204
+
+
1205
Function
mod(u,16)
1206
1/z
Delay
1207
Real
1208
Image
1214
τ
1213
2*pi*fc
2πfcτ
1211
cos(u)
1212
sin(u)
1209
1210
1215
+
+
1216
1
Audio

12

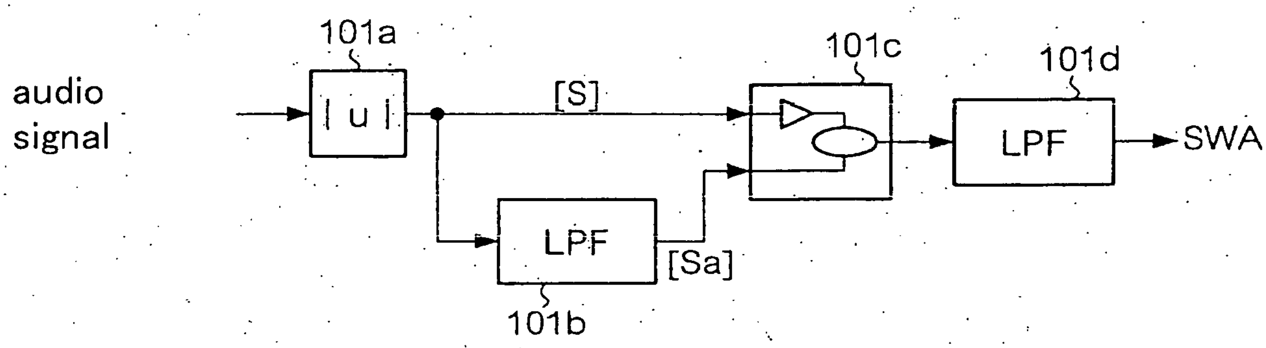
[ Fig. 17 ]


switch demodulator
total discrimination
108
edge information
level information
wave shape information
edge information
edge information
level information
wave shape information
107
Q detector
106
Level detector
105
wave shape detector
104
Y detector
103
P detector
102
Level detector
101
wave shape detector
L
R
109
L/R separation
L/R
100
audio signal

[ Fig. 18 ]

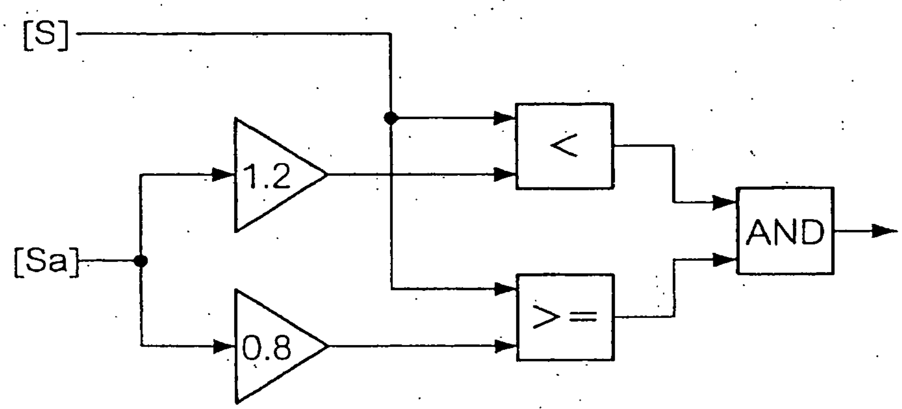

100c
1
Status
108a
104:Y detecting portion
116
NOR
OR
115
100
108b:A detector
Trigger
Status
Audio
111:Y detector
Trigger
Curr
Status
Signal
110: demodulator
Carrier Base
103:P detector
Trigger
Curr
Status
Signal
107:Q detector
Trigger
Curr
Status
Signal
100a
1
R
100b
2
L

[ Fig. 19 ]



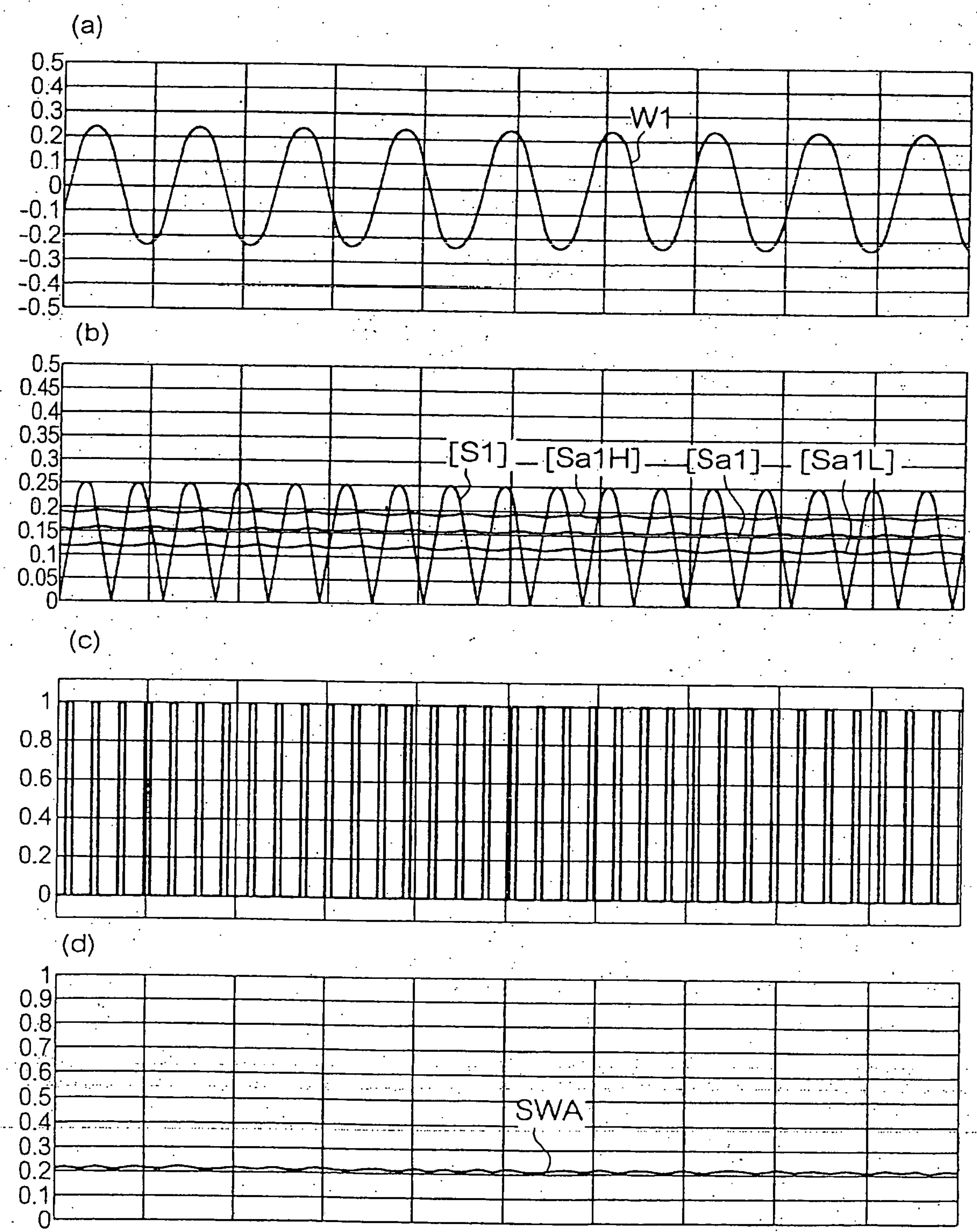

101

[ Fig. 20 ]

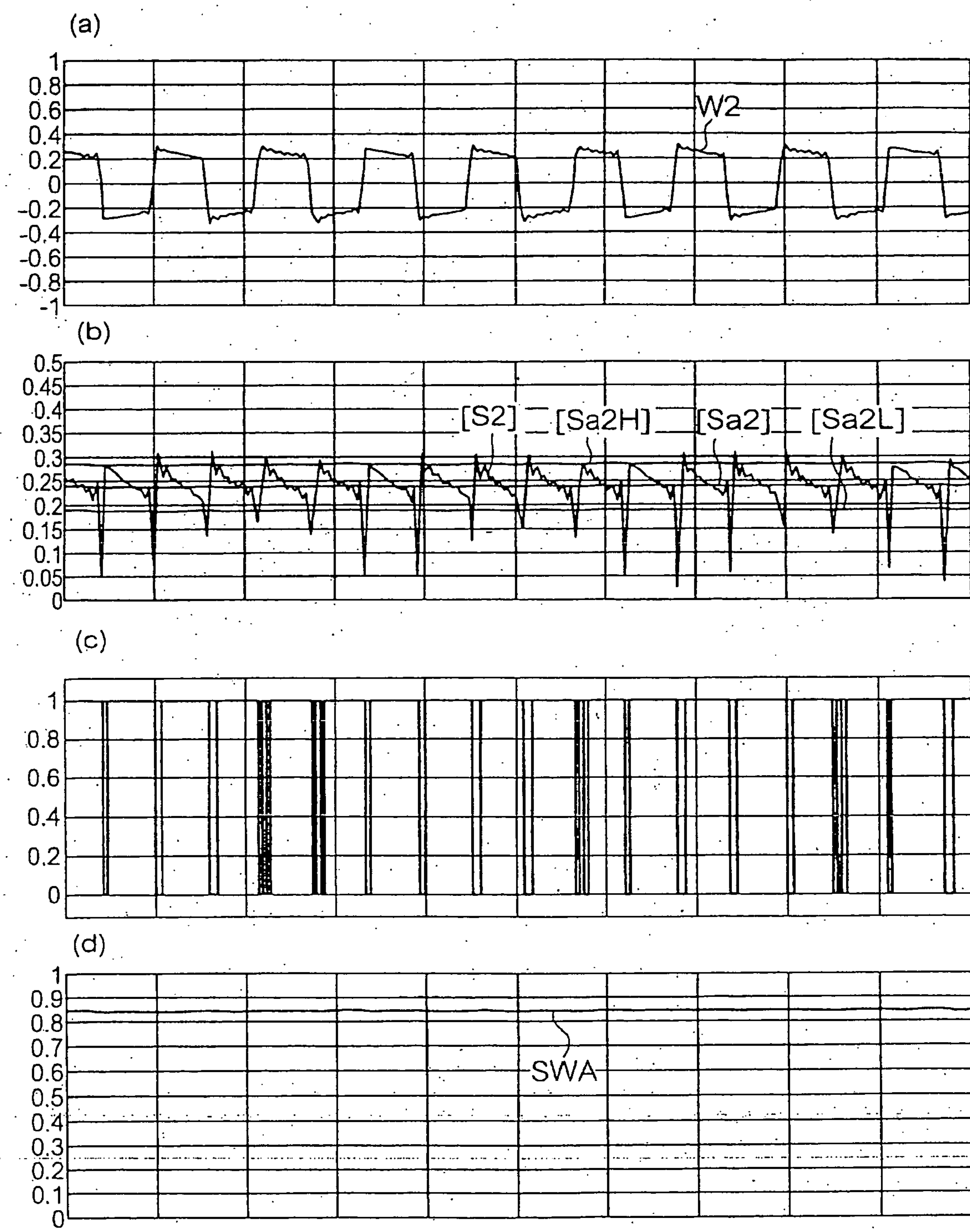



101c

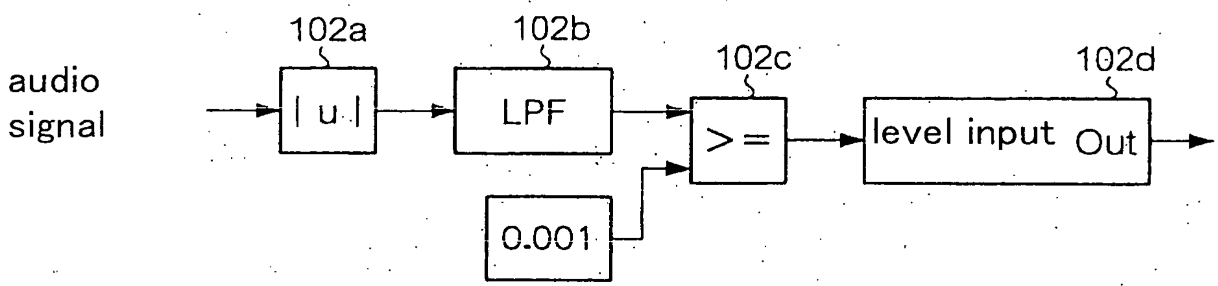
[ Fig. 21 ]


(a)
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
W1
(b)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
[S1]
[Sa1H]
[Sa1]
[Sa1L]
(c)
1
0.8
0.6
0.4
0.2
0
(d)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
SWA

[ Fig. 22 ]

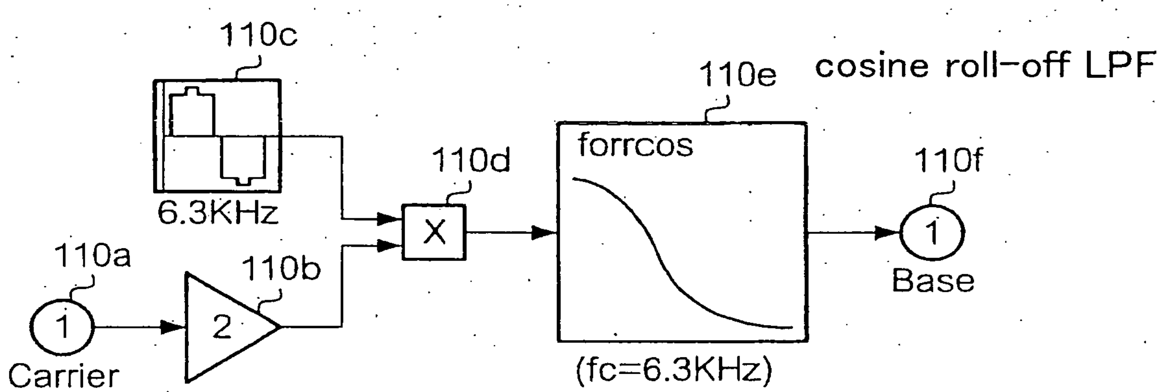


[ Fig. 23 ]



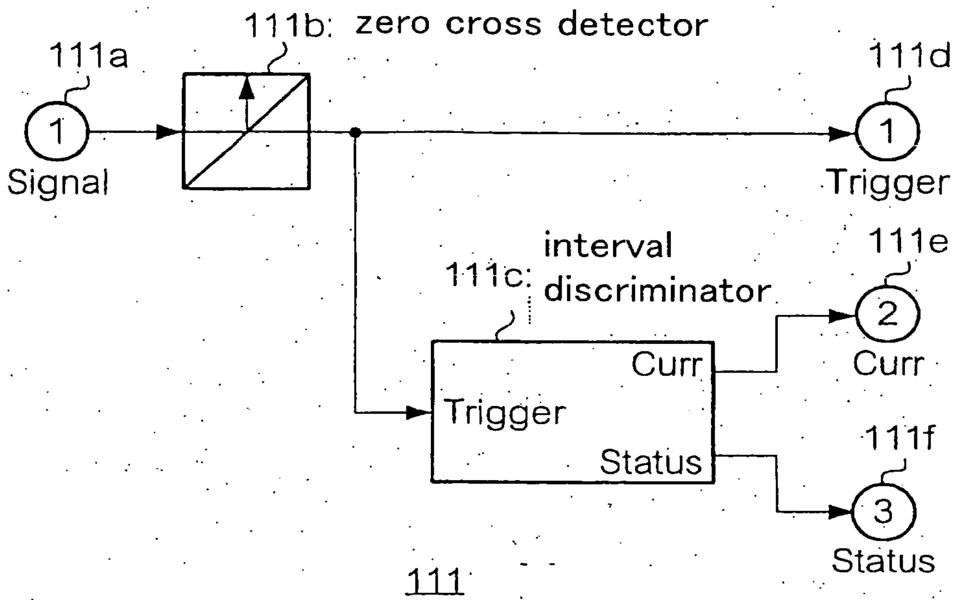

102

[ Fig. 24 ]



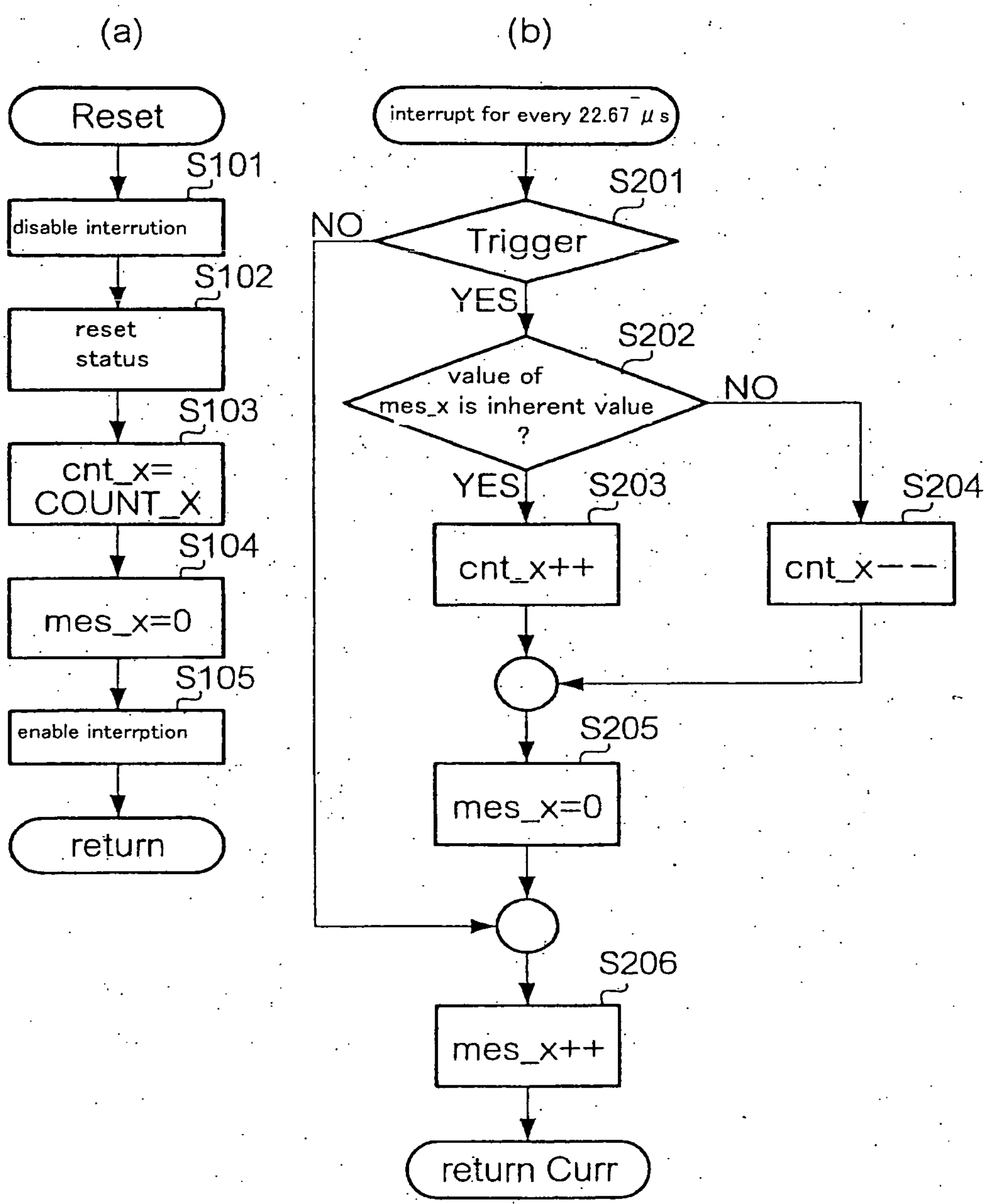

110

[ Fig. 25 ]

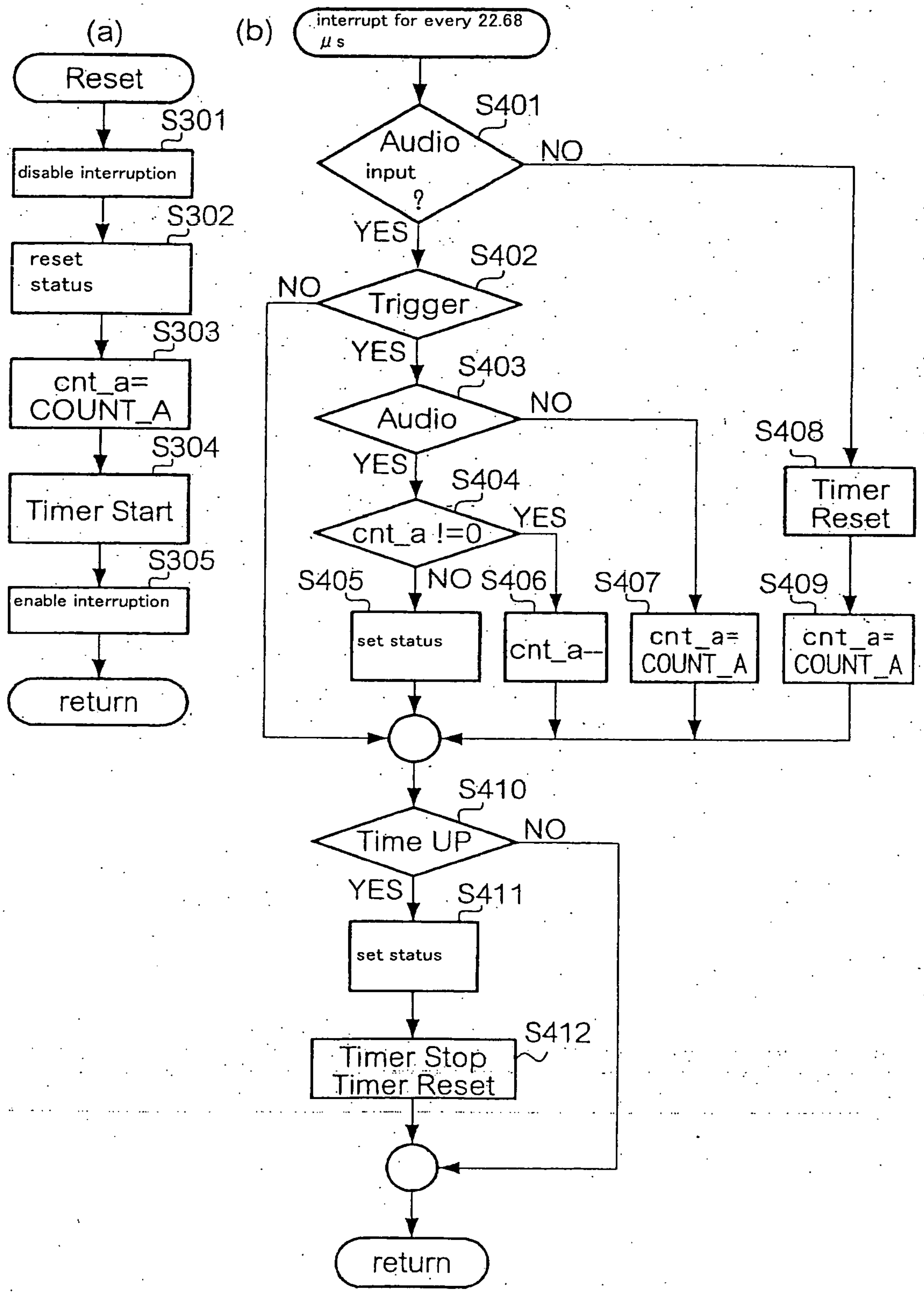

111b: zero cross detector
111a
1
Signal
111d
1
Trigger
interval
111c: discriminator
111e
2
Curr
Curr
Trigger
Status
111f
3
Status

111

[ Fig. 26 ]


(a)
Reset
S101
disable interrution
S102
reset status
S103
cnt_x= COUNT_X
S104
mes_x=0
S105
enable interrption
return
(b)
interrupt for every 22.67 μs
S201
NO
Trigger
YES
S202
value of mes_x is inherent value ?
NO
YES
S203
S204
cnt_x++
cnt_x−−
S205
mes_x=0
S206
mes_x++
return Curr

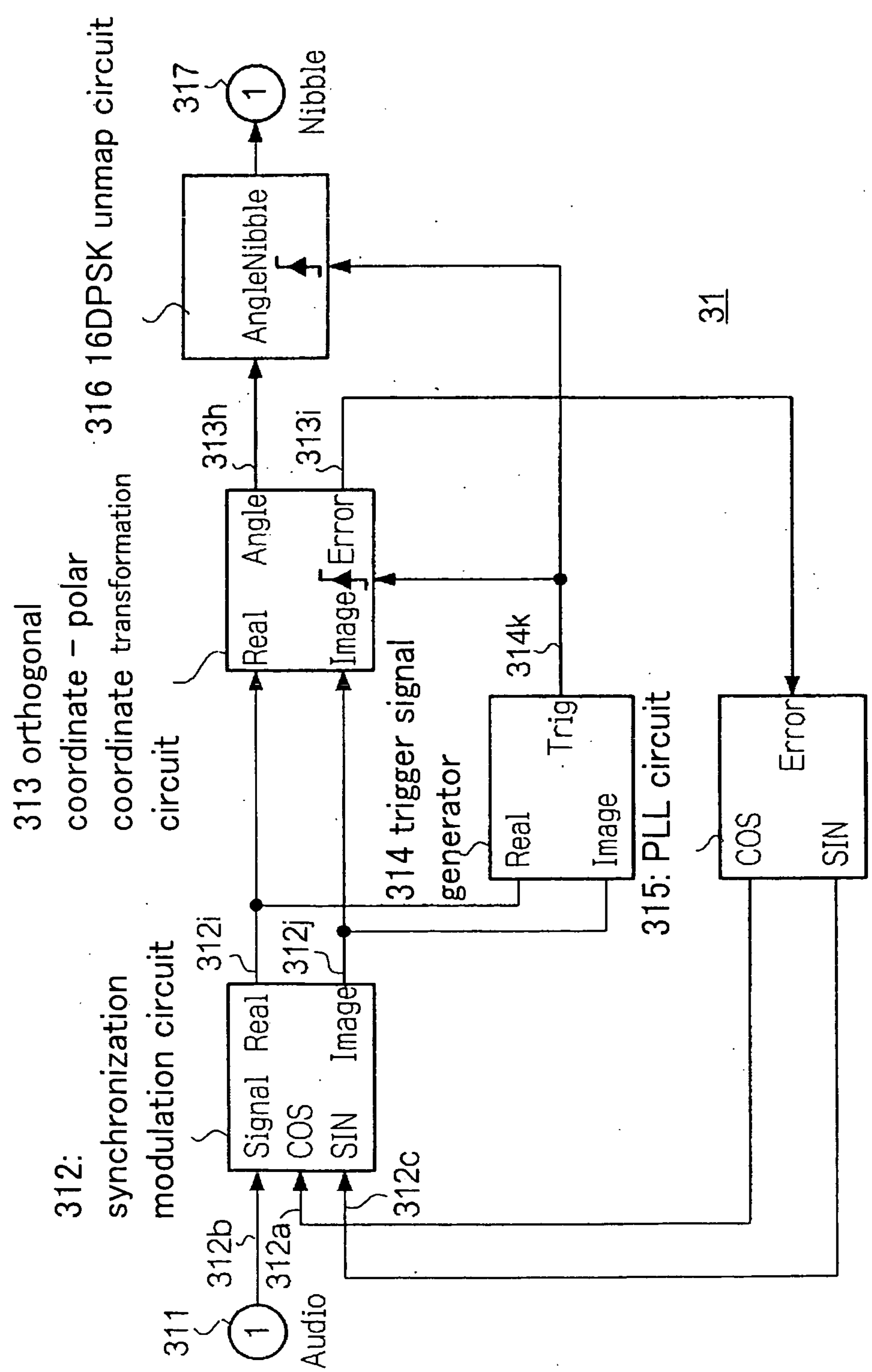
[ Fig. 27 ]


(a)
Reset
S301
disable interruption
S302
reset status
S303
cnt_a= COUNT_A
S304
Timer Start
S305
enable interruption
return
(b)
interrupt for every 22.68 μs
S401
Audio input ?
NO
YES
S402
Trigger
NO
YES
S403
Audio
NO
YES
S404
cnt_a !=0
YES
NO
S405
set status
S406
cnt_a--
S407
cnt_a= COUNT_A
S408
Timer Reset
S409
cnt_a= COUNT_A
S410
Time UP
NO
YES
S411
set status
S412
Timer Stop Timer Reset
return

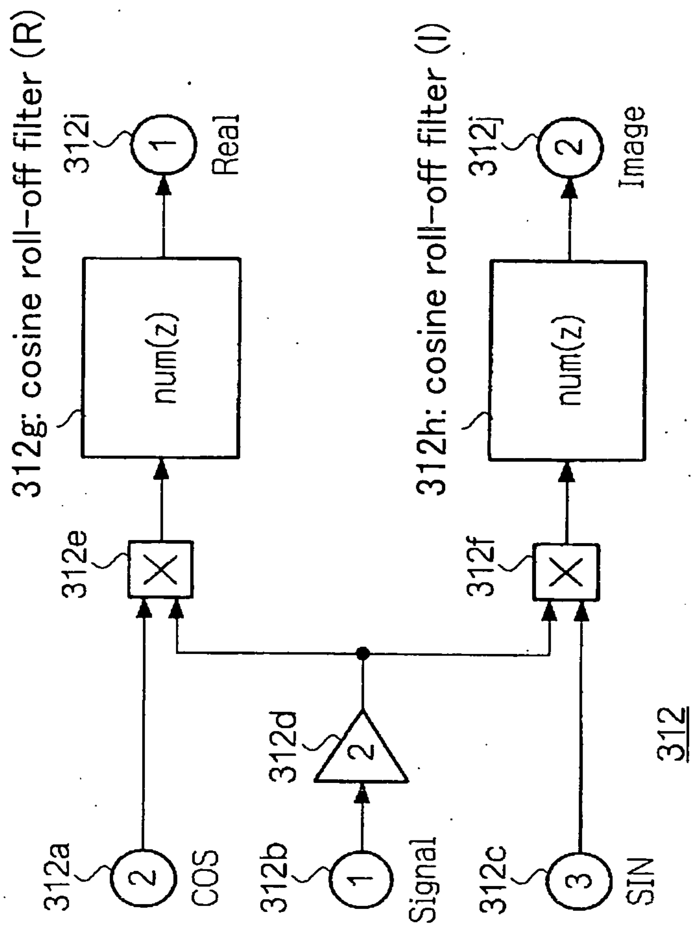
[ Fig. 28 ]

| input | Y detector | Q detector | P detector | L Level | R Level | L wave shape | R wave shape | Time-out | judgment |
|---|---|---|---|---|---|---|---|---|---|
| internal CD (no-sound in other channels as it is judged based on the header portion of the tune) | cnt_y>=TH_YH | – | – | no-sound | – | – | wav_r<TH_SINR | no | Y modulatio method |
| | – | cnt_qp>=TH_QPH | – | – | no-sound | wav_l<TH_SINL | – | no | Q modulation method when both conditions meet |
| | – | cnt_qc>=TH_QCH | – | – | no-sound | wav_l>=TH_SQRL | – | no | |
| | – | – | cnt_p>=TH_PH | no-sound | – | – | wav_r>=TH_SQRR | no | P modulation method |
| | cnt_y<=TH_YL | cnt_qp<=TH_QPL && cnt_qc<=TH_QCL | cnt_p<=TH_PL | – | – | – | – | no | Audio |
| | – | – | – | – | – | – | – | yes | Audio |
| external AUX | cnt_y>=TH_YH | – | – | – | – | – | wav_r<TH_SINR | no | Y modulation method |
| | – | cnt_qp>=TH_QPH | – | – | no-sound | wav_l<TH_SINL | – | no | Q modulation method |
| | – | cnt_qc>=TH_QCH | – | – | – | wav_l>=TH_SQRL | – | no | Q modulation method |
| | – | – | cnt_p>=TH_PH | – | – | – | wav_r>=TH_SQRR | no | P modulation method |
| | cnt_y<=TH_YL | cnt_qp<=TH_QPL && cnt_qc<=TH_QCL | cnt_p<=TH_PL | – | – | – | – | no | Audio |
| | – | – | – | – | – | – | – | yes | Audio |

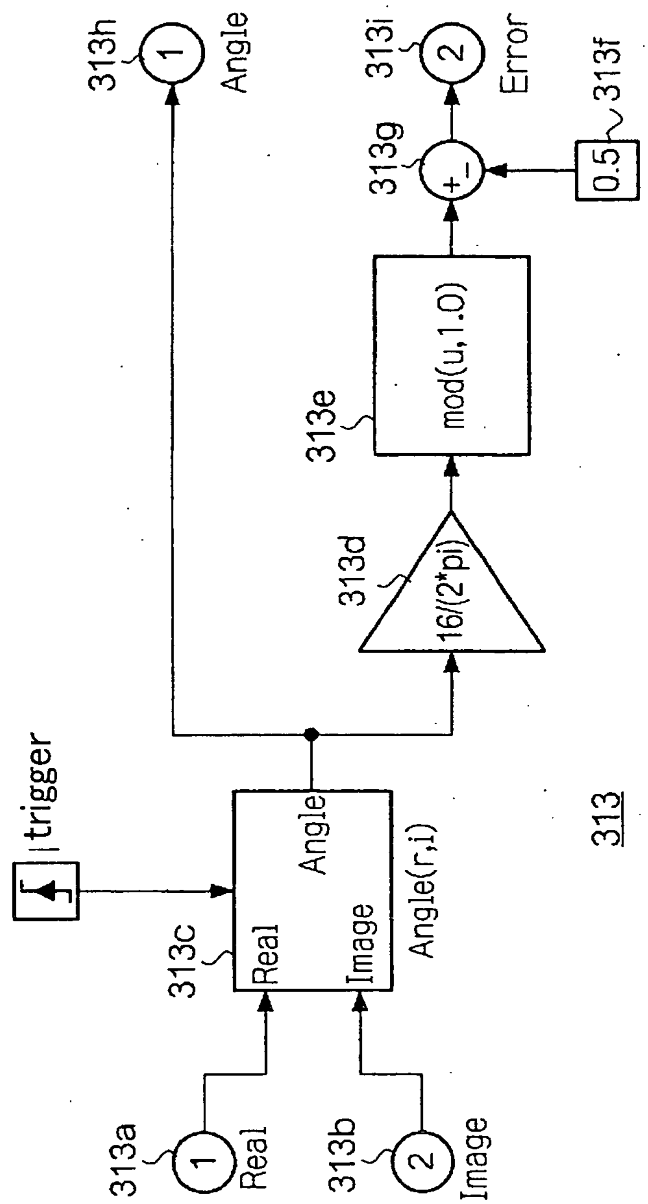
[ Fig. 29 ]


311
Audio
312b
312a
312c
312: synchronization modulation circuit
Signal
COS
SIN
Real
Image
312i
312j
313 orthogonal coordinate – polar coordinate transformation circuit
Real
Image
Angle
Error
313h
313i
314 trigger signal generator
Real
Image
Trig
314k
315: PLL circuit
COS
SIN
Error
316 16DPSK unmap circuit
AngleNibble
317
Nibble
31

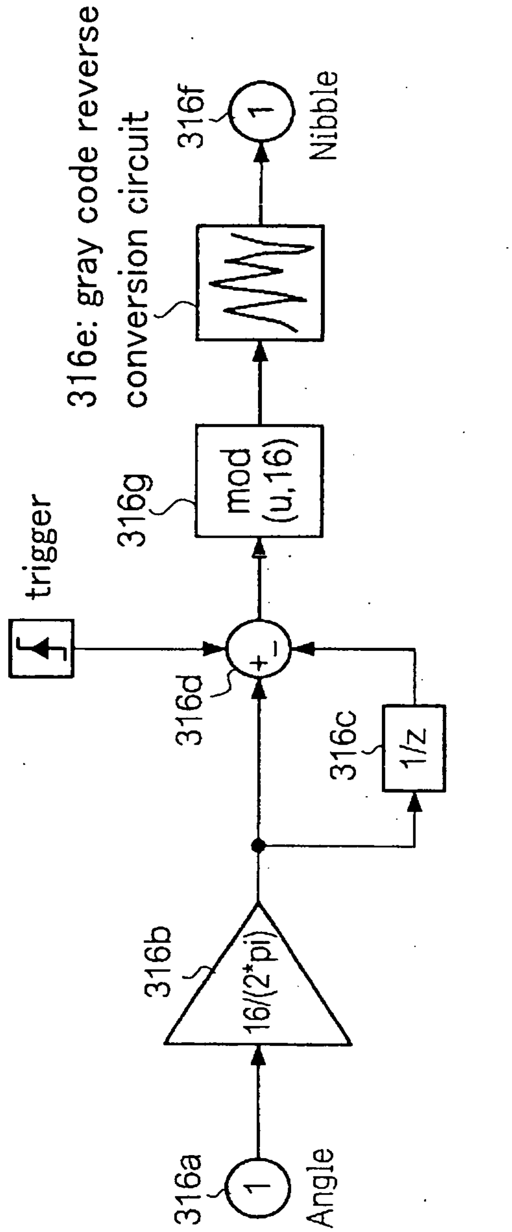
[ Fig. 30 ]


312g: cosine roll-off filter (R)
num(z)
312i
1
Real
312h: cosine roll-off filter (I)
num(z)
312j
2
Image
312e
312f
312d
2
312a
2
COS
312b
1
Signal
312c
3
SIN
312

[ Fig. 31 ]

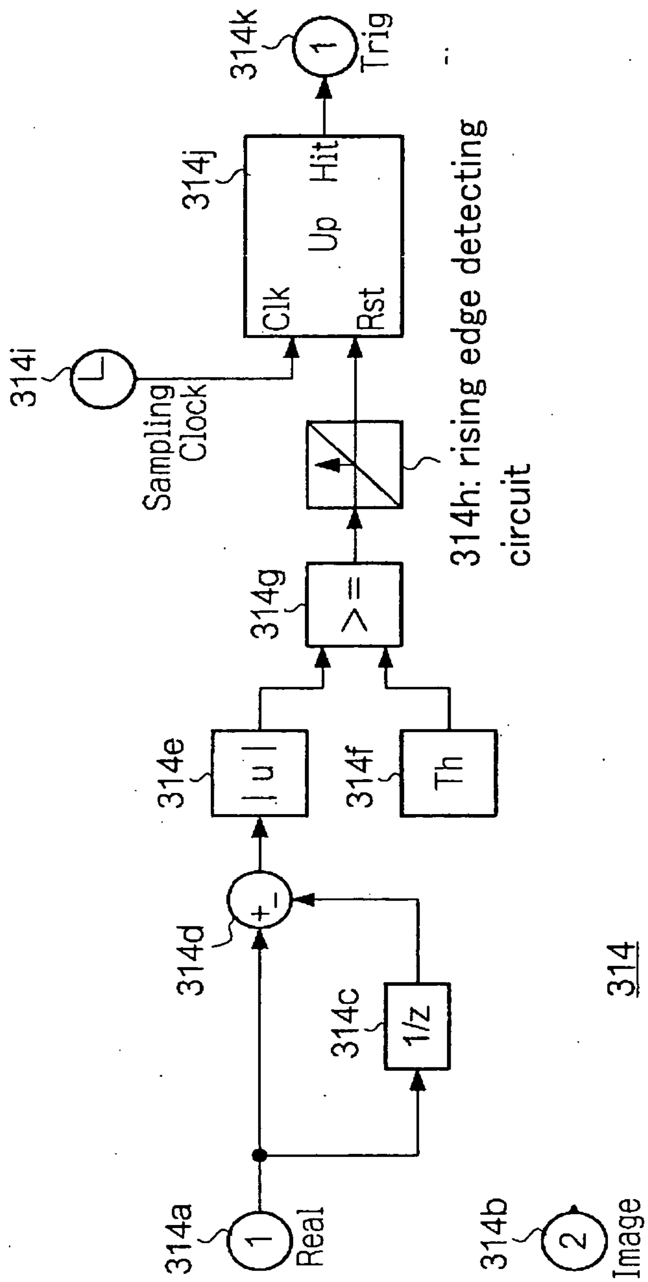

313a
1
Real
313b
2
Image
313c
Real
Image
Angle
Angle(r,i)
trigger
313d
16/(2*pi)
313e
mod(u,1.0)
313g
+
-
313f
0.5
313h
1
Angle
313i
2
Error
313

[ Fig. 32 ]

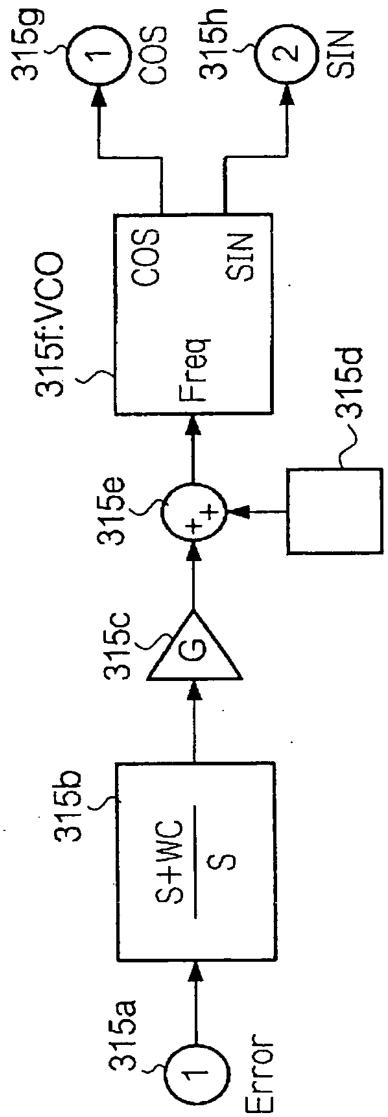

316e: gray code reverse conversion circuit
316f
1
Nibble
trigger
316g
mod (u,16)
316d
+
-
316c
1/z
316b
16/(2*pi)
316a
1
Angle

316

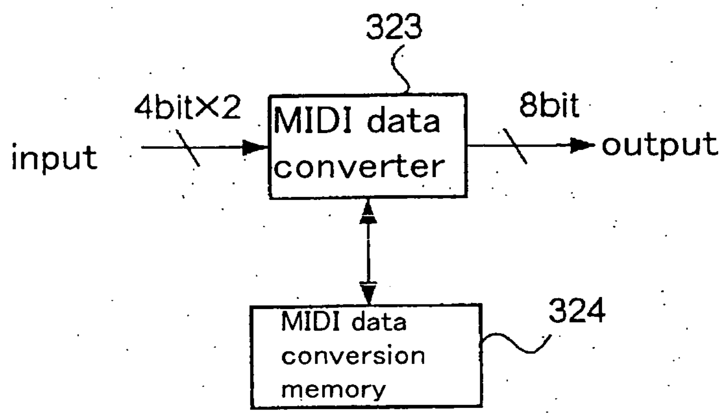
[ Fig. 33 ]


314a
1
Real
314b
2
Image
314c
1/z
314d
+
-
314e
| u |
314f
Th
314g
>=
314h: rising edge detecting circuit
314i
Sampling Clock
314j
Clk
Up
Hit
Rst
314k
1
Trig
314

[ Fig. 34 ]

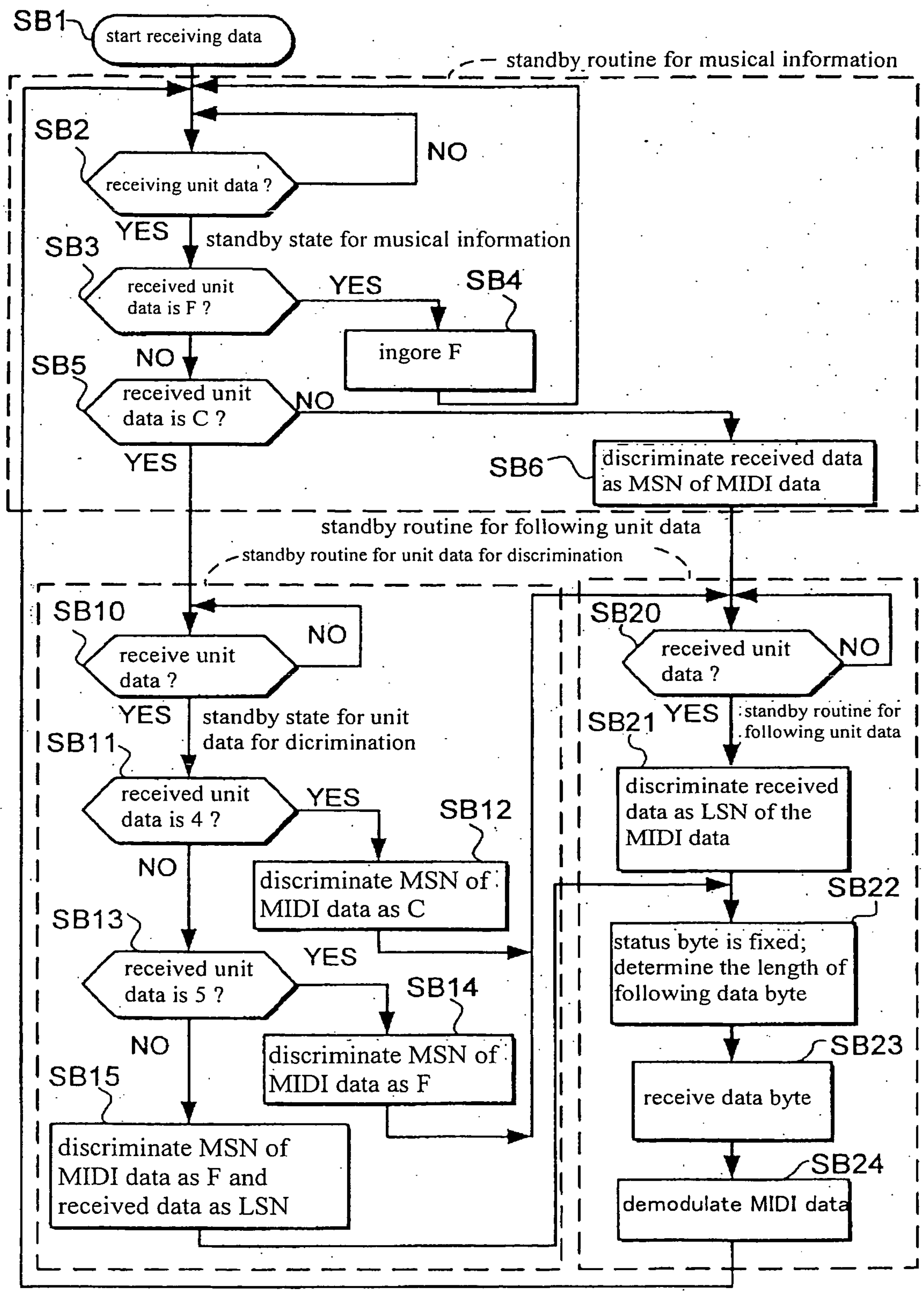

315a
1
Error
315b
S+WC
S
315c
G
315e
+
+
315d
315f:VCO
Freq
COS
SIN
315g
1
COS
315h
2
SIN

[ Fig. 35 ]

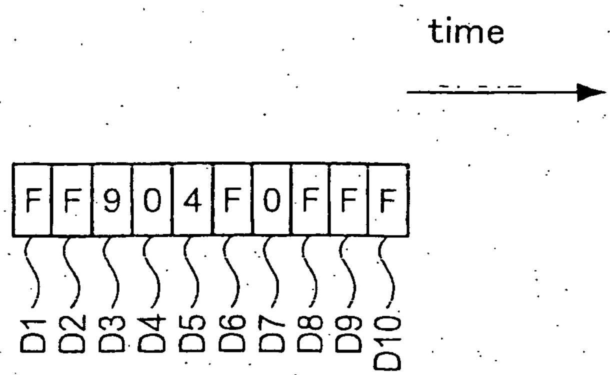



32: Data --> MIDI conversion module

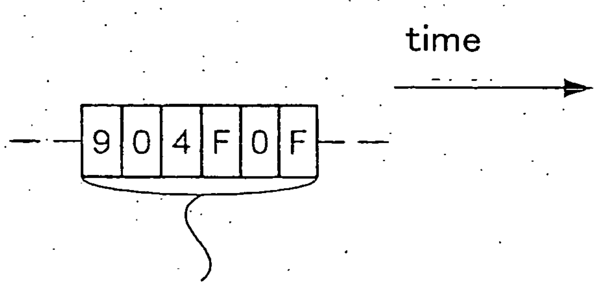
[ Fig. 36 ]


SB1
start receiving data
standby routine for musical information
SB2
receiving unit data ?
NO
YES
SB3
standby state for musical information
received unit data is F ?
YES
SB4
ingore F
SB5
NO
received unit data is C ?
NO
YES
SB6
discriminate received data as MSN of MIDI data
standby routine for following unit data
standby routine for unit data for discrimination
SB10
receive unit data ?
NO
YES
standby state for unit data for dicrimination
SB11
received unit data is 4 ?
YES
SB12
discriminate MSN of MIDI data as C
NO
SB13
received unit data is 5 ?
YES
SB14
discriminate MSN of MIDI data as F
NO
SB15
discriminate MSN of MIDI data as F and received data as LSN
SB20
received unit data ?
NO
SB21
YES
standby routine for following unit data
discriminate received data as LSN of the MIDI data
SB22
status byte is fixed; determine the length of following data byte
SB23
receive data byte
SB24
demodulate MIDI data

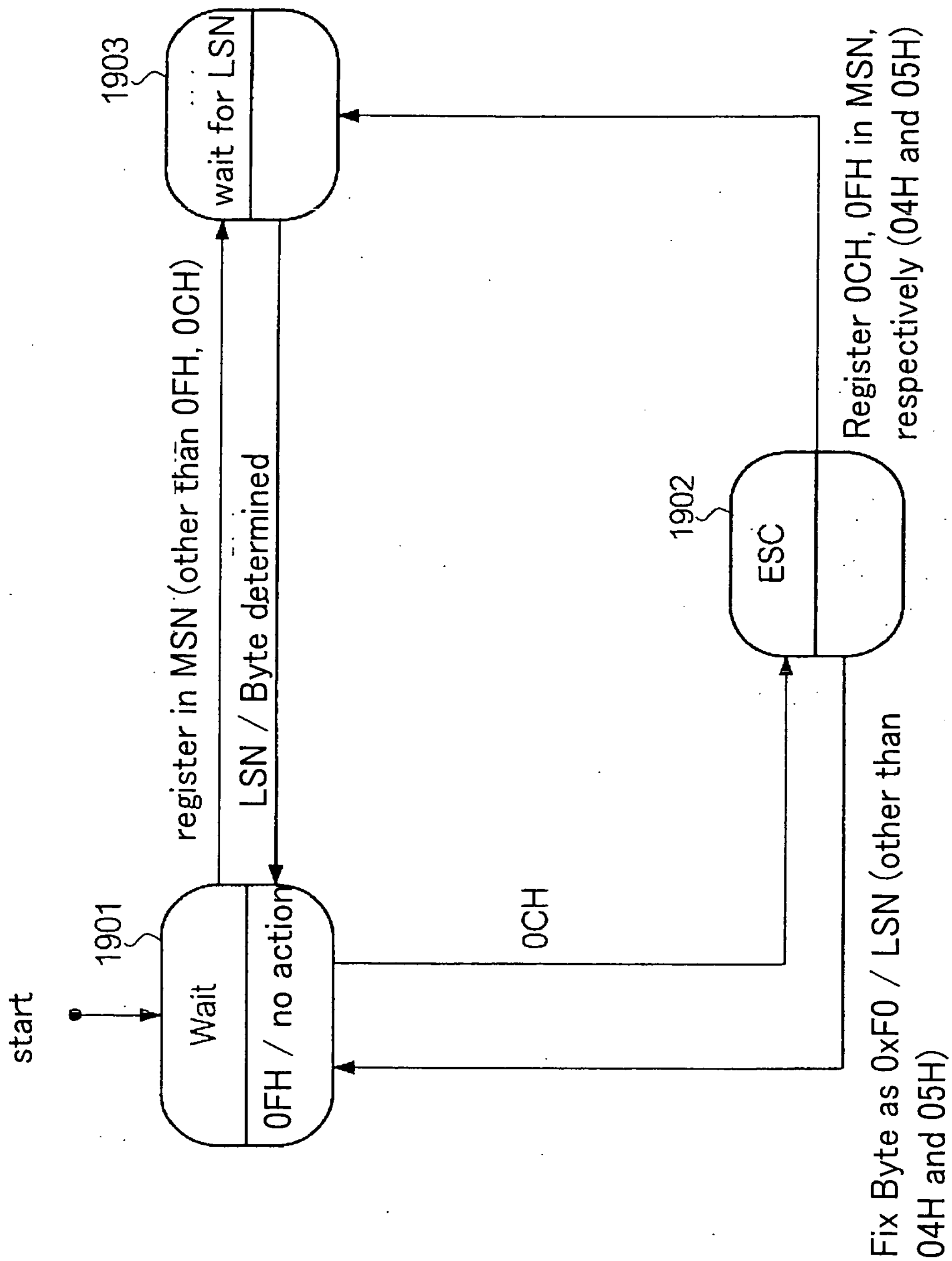
[ Fig. 37 ]


time
F
F
9
0
4
F
0
F
F
F
D1
D2
D3
D4
D5
D6
D7
D8
D9
D10

[ Fig. 38 ]


time
9
0
4
F
0
F
MIDI data

[ Fig. 39 ]


start
1901
Wait
0FH / no action
register in MSN (other than 0FH, 0CH)
LSN / Byte determined
1903
wait for LSN
0CH
1902
ESC
Register 0CH, 0FH in MSN, respectively (04H and 05H)
Fix Byte as 0xF0 / LSN (other than 04H and 05H)

[ DOCUMENT NAME ] ABSTRACT DOCUMENT

[ ABSTRACT ]

[ PROBLEM ] To provide a modulation method discriminating system and the method for precisely discriminating a modulation method of a modulated signal acquired by modulating the MIDI signals or the like, a demodulator and the method thereof to select a demodulation process associated with the modulated signal, an audio reproducing system and the method thereof for correctly reproducing audio signals from the modulated signals, and an information recording medium for recording the program thereof.

[ SOLVING MEANS ] A detector 100 in an audio reproducing system discriminates the wave shape of audio signals in respective channels, which are input thereinto, by the wave shape discriminators101 and 105 and also detects whether the signals are input from respective channels by the level detectors 102 and 106. Further, the modulation method of the audio signals, which are input thereinto, are detected by respective detectors 103, 104 and 107 to discriminate the modulation method of the audio signal based on all of the output values and the demodulation method of the demodulator is switched.

[ SELECTED FIGURE ] Fig. 17

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